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THE NORTH GERMAN-LLOYD STEAMER "Kaiser Wilhelm der Grosse" arrived at New York on April 5, 5 days and 20 hours out from Southampton. This lowers the west-bound record between these ports 2 hours 35 minutes. The best day's run was 561 miles; the total distance covered was 3,120 miles, and the average speed was 22.20 knots per hour. In September last the same ship made the best previous westward record by covering a distance of 3,050 miles at the average rate of 21.39 knots per hour. She had good weather excepting about 12 hours of storm off the Banks.

THE COAL CONSUMPTION OF WARSHIPS is a heavy item, according to English press accounts. It is said that the English battleship "Powerful" burned 8,300 tons of coal on her late voyage to China. Of this 3,400 tons were consumed in running the auxiliary engines for dynamos, ventilation, etc. When steaming at 11½ knots the propelling engines burn only about 100 tons per day; but with one-half maximum power developed she burned 293 tons in one day. She carries the unusual quantity of 1,500 tons in her bunkers; or enough for 12 days at sea at moderate speed, though not 2 days at her maximum speed of 22 knots. The "Powerful" has Belleville boilers.

THE MONTREAL, OTTAWA AND GEORGIAN BAY Ship Canal project is assuming business-like proportions. Ottawa press items say that the promoters offer to expend about $20,000,000 in securing a 14-ft. waterway on this route, in consideration of a subsidy of $300,000 per annum for twenty years, of which subsidy not one cent is to be paid until five years after the completion of the canal. An English company is said to be already formed wth ample means for carrying out the undertaking, and the contract would be taken by the well-known firm of S. Pearson & Co. This canal, by way of the Ottawa River and Georgian Bay, would cut off 1,100 miles in distance between Chicago and Liverpool, and save five days in time. McLeod Stewart, of Ottawa, is one of the prncipal promoters of the enterprise.

THE NICARAGUA CANAL COMMISSION has returned and the newspapers are full of what "they will report." Nothing will be certainly known on this head until the report is sent to Congress; but some of these rumors seem to have a foundation. One of the principal items of importance to the enterprise is the statement that rock has been found at the site of the Ochoa dam, "about 20 ft. below sea-level." Another rumor is that a better site for a dam is being investigated, at Tambor Grande, 14 miles below Ochoa. It is said that this crossing is only 400 ft. wide and is flanked by high, rocky hills on both sides; if feasible, this location would much reduce the length and cost of the proposed embankment work in the San Francisco Basin. The question to be yet settled is that of overflow of the adjoining territory and the continuity of the ranges of hills; this work of development has been carried three miles into Costa Rica, but is not yet finished. There is also some talk of an outflow weir towards the Pacific for the flood waters of Lake Nicaragua, and making the dam on the San Juan higher than any known flood. The rumored provisional estimate of total cost, by the Commission, is about $100,000,000, as compared with the $65,000,000 of the Canal Co. and the $133,000,000 estimate of the Commission of 1895.

INTERCEPTING SEWER TUNNELS, 16 and 20 ft. diameter and 2¼ miles long, are to be built by the city of Chicago on Lawrence Ave (North Side) and 39th St. (South Side), at an estimated cost of $450 000 and $950,000 respectively. These will carry to the Chicago River the sewage collected by a system of sewers intercepting the present main sewers. The work will be in soft, wet clay, and is to be done by the pneumatic process. Contracts will be let April 13 by Mr. L. E. McGann, Commissioner of Public Works, and both tunnels are to be completed by April, 1899.

LARGE WELDED STEEL PIPES, says "Engineering," have been adopted for the Birmingham Water-Works from the designs of Mr. James Mansergh. These pipes are 42-in. diameter and 24 ft. long, and the thickness varies from ⅛ to 11-16-in., according to pressure to be resisted. Siemens-Martin mild steel will be used, and the test-pressure is 600 lbs. per sq. in. In all, 7,000 tons of this pipe will be made within the next two years by Thomas Piggott & Co., of the Atlas Works, Spring Hill, Birmingham.

FURTHER CONSOLIDATION OF MECHANICAL FILTER companies has just been effected, the Cumberland Manufacturing Co. having disposed of its interests in the Warren filter to the New York Filter Manufacturing Co. Mr. W. B. Nye, for many years Manager of the Cumberland Manufacturing Co., will be Assistant Manager of the New York Co., retaining his office in Boston.

THE WATER METER SYSTEM AT SYRACUSE, N. Y., is coming into quite general use. During 1897 over 4,200 families who used meters consumed less than 3,000 cu. ft. of water each, for which they were charged only $5, less 25 cts. for prompt payment. The allowance has now been increased to 3,600 cu. ft. of water a year, or 74 gallons per family per day for $5. All water consumed in excess of this amount is to be paid for at the rate of 14 cts. per 100 cu. ft., or a little less than 19 cts. per 1,000 gallons, which gives 53 gallons of water for 1 ct. Where a meter is not used, a family would pay $5 for the first faucet, $5 for a water closet, $4 for a bath tub, and $6 for lawn sprinkling, a total of $20. We are indebted to Mr. Wm. R. Hill, M. Am. Soc. C. E., Chief Engineer and Superintendent of the Syracuse Water-Works, for the above information.

A FULL WATER METER SYSTEM has been established in Berkeley, Cal., by an ordinance regulating the rates to be charged for water in that town for the year ending June 30, 1899. Water is furnished by a private company, but under the state constitution municipalities regulate water rates each year. The meter rates have been fixed at 30 cts. per 1,000 gallons, but with a minimum rate of $1.50 per month. We are indebted to Mr. H. I. Randall, of Berkeley, for the above information.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred March 29 on the Peoria Eastern Ry., about 3½ miles east of Bloomington, Ill. The accident was caused by the tender jumping the track at the foot of a hill where there was a trestle across a small creek. The tender and three passenger cars bumped across this on the ties and fell down an 8 ft. embankment at the other side. Twenty-seven persons were injured, four so seriously that they may die.

THE BREAKING OF THE LEVEE on the Ohio River in front of Shawneetown, Ill., occurred on April 3, and latest reports state that 23 to 30 persons were drowned, while between 1,500 or 2,000 were made homeless. Shawneetown is about 75 miles below Evansville, Ind., on the Ohio River. It is in a valley, with hills at the rear, while the river front is protected by a 25 ft. levee, which extends from hill to hill. This levee was carefully watched and repaired, but the very high water in the river caused its failure, which occurred so suddenly that with practically no warning the 2,000 inhabitants were caught. Frame houses were overturned or destroyed, and practically the entire town was inundated with 5 to 20 ft. of water.

A FLYWHEEL BURST in the Greenridge Iron Works, Scranton, Pa., on March 29, killing one man and injuring two others. The wheel weighed 14 tons, and was running at about 450 revolutions per minute.

AN EARTHQUAKE on the evening of March 30 shook San Francisco quite severely, doing considerable damage. Several houses were shaken down, and nearly every building in the city suffered in some slight degree. It is estimated that the damage at the Mare Island Navy Yard will amount to $250,000. The shock was apparently limited to Northern California, running from east to west. Instruments at the University of California show that the shock lasted between 30 and 40 seconds. It is considered the most severe shock that San Francisco has felt since 1868.

THE TRANS-SIBERIAN RAILWAY, says the Russian Minister of Roads and Communications in a report dated Feb. 24, is open to traffic to Krasnoiarsk, and the general progress for the three years, 1895-97, is as follows: Earthwork executed, 100,000,000 cu. yds.; rails laid, 1,982 miles; ballast deposited, 2,044 miles. On the Trans-Baikal line 241 bridges have been built and 685 miles of main line and sidings have been laid. The Northern Ussuri line approaches completion; and on Sept. 1, 1897, the first through train arrived at Khabarovsk from Vladivostock. For the crossing of Lake Baikal, the parts of an ice-cutting ferryboat and the engines for a floating dock are now at Krasnoiarsk; and an ice-cutting ferryboat is being put together on the east bank of Lake Baikal. Arrangements are being made to improve the navigation of the rivers Angara, Schilka, Amur and Ussuri, and two dredgers and two steamers with barges are now in use.

AN ABYSSINIAN RAILWAY is proposed from Djibouti, the principal seaport town of French Somaliland, in East Africa, to Harar, in Abyssinia, a distance of 280 miles. A French syndicate, with C. Havard, of Djibouti, as secretary and general manager, has already made a start in constructing a one meter gage railway on this line, the whole of which has been surveyed. Owing to the excessive heat, natives alone can work upon it. The exceedingly valuable exports from this country are now conveyed to the sea coast by camel caravans averaging 10 miles per day; and the volume of this trade is said to fully justify the undertaking.

THE RUSSIAN PRICE FOR STEEL RAILS, for 1898, says U. S. Vice Consul Thomas Smith, of Moscow, has been fixed by the government at $34.72 per ton, gold, instead of $50.84 per ton, the prevailing price for the last five years. The government forced this price on the Russian rail syndicate, under the threat of buying abroad. This reduction was made to prevent the mills making bar and other iron from changing their plant to rail-mills exclusively, under the inducement of the former 60 to 70% profit on steel rail manufacture.

THE PROSPECTS FOR RAILWAY CONSTRUCTION during 1898 seem to be slightly more favorable than at this date in 1897, according to figures published by the "Railway Age" in its issue of April 1, 1898. According to these figures there are 375 railway lines, comprising some 20,000 miles of track, which at the present time show some vitality and some likelihood of at some time being built, either wholly or in part. Already at the end of the first three months of 1898, 375 miles of new track have been laid, and work is in progress upon 90 different lines aggregating 2,725 miles of track, while 725 miles more are now under contract or are about to be put under contract. It is, of course, not to be expected that all of the work even thus far advanced will be carried to completion this year, but our contemporary thinks it will not be surprising if the year's new construction should amount to 3,000 miles and that it is improbable that it should fall below 2,500 miles.

A BRIDGE across the channel separating Denmark from the Island of Funen is proposed in a bill now before the Danish legislature. The length would be about 4,500 ft., and spans of 1,000 ft., resting upon metal piers, are suggested, with a roadway 130 ft. above high-water mark. The estimated cost is $3,250,000.

THE STATE CAPITOL COMMISSION OF PENNSYLvania has decided to ask for new bids, and will prepare new plans and specifications to meet some of the criticisms which have been made upon the former ones. The whole work of securing a new capitol building seems to have been muddled from the start, and it is difficult to determine from the conflicting statements of the various parties in interest just where the blame lies. This much is certain, however, that only nine months remain before the convening of the next legislature on Jan. 1, 1899, and it will be exceedingly difficult to have a new capitol building of creditable architectural design completed and ready for use by that time.

U. S. CIVIL SERVICE CANDIDATES ARE WANTED for the semi-annual examination of April 25, in the special, mechanical and professional grades. The Commission asks for candidates for admission as assistant surgeons in Marine Hospital Service, aid in coast and Geodetic Survey, assistant in Department of Agriculture, assistant examiner in Patent Office, hospital stewards in Marine Hospital Service, inspectors and assistant inspectors of hulls and boilers in Steamboat Inspection Service, marine engineer in Marine Hospital Service, weather observer in Department of Agriculture, etc. Candidates must apply in time to have examination papers sent to them by the U. S. Civil Service Commission, of Washington, D. C.; but the "ten day before examination" clause, for the completion of papers, is waived.

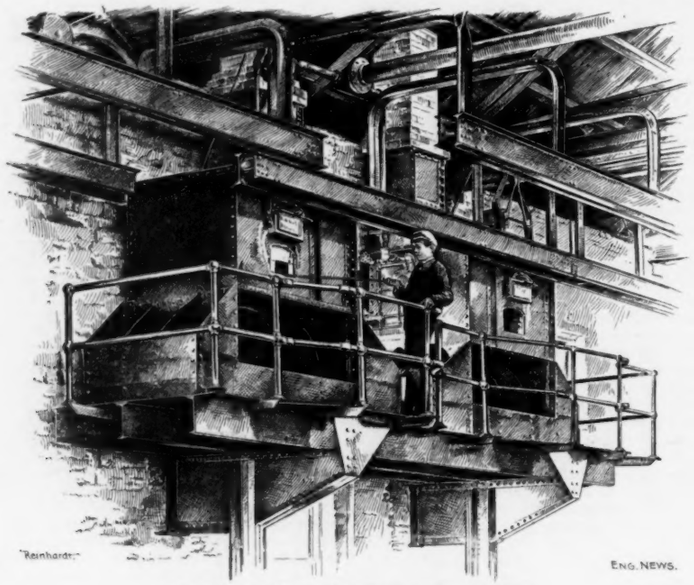
RIVET-HEATING FURNACES IN A BRIDGE AND STRUCTURAL IRON PLANT.

In shops for the construction of steel bridges and general structural work the location and form of the rivet-heating furnaces are matters of considerable importance; economy in floor space occupied must be considered, as well as the excessive heat and gas usually arising from these furnaces and their effect upon the workmen in summer. The furnaces here illustrated and briefly described were designed to meet the conditions here referred to by Mr. W. H. Roney, Consulting Engineer for steel structures and bridges, of 756 Monadnock Building, Chicago, Ill. These furnaces have been in use for eighteen months and give perfect satisfaction.

As shown in the sketch, the two heating furnaces are elevated 8 ft. above the shop floor and rest upon two cantilever girders supported by two 6-in. Z-bar columns. One end of each girder is built into the shop wall and the columns are so located that the center of gravity of the furnaces and the filled rivet-bins beneath them will fall between the columns and the wall. With this arrangement the floor space actually occupied measures only 5 × 3 ft. Above the cantilevers a steel plate platform is carried by steel beams and channels resting on the girders. On the platform are built the steel frames for the furnaces and the rivet-bins, all made of ¼-in. plates and 2½ × 2½-in. angles. There are three rivet-bins under each furnace and three at each end, making in all twelve bins for as many assorted sizes of rivets.

The furnaces are fitted with burners for using natural gas, and the necessary blast is supplied from the compressed-air system employed in the shop, and also by a blowing machine, so that they can be operated by either. Mr. Roney, who designed these burners, has added a steam jet for keeping the mouth of the burners cool. These burners open into an arched brick chamber, 12 ins. wide and 12 ins. high by 8 ins. deep, the bottom of which is 6 ins. above the bottom of the furnace. The flues lead under and around this chamber and up through the chimneys. The furnaces themselves are 28 ins. long, 24 ins. high, interior measurement, with an arched crown. The walls are 8 ins. thick; the bottom is of brick, two courses thick, and the crown arch is 8 ins. thick, with the top leveled up with clay. The arch is so arranged that it can be taken out and rebuilt without disturbing the rest of the furnace.

A gas-pipe rail surrounds the platform, and two gas-pipe ladders lead from the floor to the platform. In front of each furnace is an octagon projection, permitting the operator to have a good view of the shop floor beneath and enabling him to toss the heated rivets to any desired point in the riveting department below. The arrangement has been found to be very convenient; the rivet-bins are ample for the storage of various sizes of rivets and these are near at hand; the intense heat and the escaping gases do not incommode the workmen, and the entire appliance being made of steel there is no danger of fire from hot rivets.



RIVET HEATING FURNACES IN A BRIDGE SHOP.

THE STEEL TANK GRAIN ELEVATOR "GREAT NORTHERN" AT BUFFALO, N. Y.

(With full-page plate.)

To all but a few of our readers doubtless the exterior aspect of the modern storage elevator for grain is familiar enough, but a much smaller number probably is acquainted with the interior arrangement of these structures. Briefly described, the main body of the building, called by elevator men "the house," is mostly occupied with bins for storing the grain, while the surmounting structure, which is generally three stories high, and is called the "cupola," contains the operating machinery and working rooms. Generally the topmost story of the cupola contains the leg-driving machinery and turnhead spouts; the middle story, the garners, and the lowest story, the weighing hoppers and cleaning machines. Below the cupola and main roof, and extending over the entire width and length of the house is the distributing or spout floor. Here are the conveyors for transporting lengthwise of the building, and the distributing spouts for transferring by gravity from the scale hoppers to the bins. By means of the "legs," reaching from the bottoms of pits sunk below the foundations of the bins to the topmost story of the cupola, and containing bucket conveyors, the grain is elevated to the turnhead spouts and discharged into the garners. From these it passes to the lower floors where it is weighed, cleaned, if desired, and finally spouted to its proper bin.

Such briefly is the construction and operation of the modern grain elevator in its elemental features. The "Great Northern" elevator consists essentially of the same principal elements, viz., a house, cupola and transferring apparatus. Its distinctive features are the cylindrical steel tanks with hopper bottoms, mounted on columns, which take the place of the usual rectangular wooden bins; the elaboration of the conveying and hoisting appliances and their operation by electric power; and, finally, the use of steel for the entire structure above the foundations, except for the brick walls enveloping the house.

Two considerations mainly led to the use of steel in the place of wood. The average life of the wooden elevator is not much over 25 years, but steel, if properly cared for, will last indefinitely. Again the steel elevator will not need to be insured from fire, or if it is insured the rate will be a minimum. The saving in this item of insurance alone, it was considered, would soon repay the first cost of construction.

Structural Features.

For the purpose of description the structural features of the Great Northern elevator may be considered under three heads: (1) The foundations; (2) the columns, and (3) the floor and roof construction.

Foundations.—Excavation for the foundations was begun late in February, 1897. Over an area of 420 × 150 ft. the earth was excavated to low water level, about 8 ft. below the natural surface, and 6,000 maple and hemlock piles from 12 ins. to 14 ins. in diameter were driven to a depth of from 45 ft. to 50 ft., to rock. These piles were driven 2 ft. apart c. to c. in clusters of 20 and 30 piles. On the top of each cluster of piles a grillage composed of two layers of 4 × 12-in. oak timbers drift-bolted to each pile was placed. These grillages supported piers of Kettle River sandstone laid in Alpha Portland cement mortar, upon which were placed the cast-iron column bases weighing 1,000 lbs. each. The maximum unit pressure brought upon the capstone was placed at 700 lbs. per sq. in., and the greatest load allowed on any one pile was 25 tons.

Columns and Circular Girders.—The design, as already stated, having provided for cylindrical storage bins or tanks of steel elevated above the ground line, the problem of supporting them was an important one. The means employed consisted of eight steel columns to each large tank. These columns are 25½ ft. long and rest on the piers already described. Each group of eight columns support a circular steel girder to which the shell of the tank is riveted at the juncture of the hemispherical bottom with the cylinder. Fig. 1 is a part plan showing the arrangement of the columns and cylinders; Fig. 2 shows the construction of columns A and C; and Fig. 3 shows the construction of columns B, D and E. Fig. 3 also shows details of the circular girder construction for the smaller tanks.

In these main columns, as the ratio of length to the radius of gyration is small, the unit strain given by column formulas was but slightly reduced, and a unit strain of 16,000 lbs. per sq. in. was allowed. The estimated load on each of the main columns is 700 tons, made up of one-eighth the weight of two adjoining bins of wheat, the dead load of steel, and the concentration of the dead, live and wind loads from the cupola columns to be described further on.

The function of the circular girder is to transmit and distribute the column concentrations to the shell of the tank without overstraining the metal. These girders were designed as continuous beams to carry a uniformly distributed load of 40,000 lbs. per lin. ft. The overturning effect due to their curved plan is taken care of by brackets. It will be noticed that the webs of these girders are stiffened by 5 × 5-in. angles at the points of support, and by 3½ × 3½-in. angles at intermediate points. In the lower flange the two angles are placed on the opposite sides of the plates, as in ordinary plate girder construction, but both upper flange angles are placed on the outside of the web in an inverted position. The same rivets which attach these angles to the web also connect the bins to the circular girder.

Resting on the circular girder directly over the Columns A, Fig. 1, are the columns which support the cupola floors and roof. For the length between the circular girder and the distributing floor, which is at the level of the tops of the tanks, these columns are composed of a plate and four angles; they are then changed to Z-bar columns for one story, and finally resume the plate and four angles construction to the cupola roof trusses. This arrangement is indicated by Fig. 4, which shows a half-section of the cupola and also the main roof construction. The cupola walls and roof covering is corrugated iron.

Floors.—The main or distributing floor is at the level of the tops of the tanks, and it consists of 6-in. I-beams running lengthwise of the building and spaced 2 ft. apart c. to c., covered by a steel plate flooring ⅛-in. thick. To carry the I-beams heavy angle stiffeners are bent to fit the tops of the tanks and a light lattice girder is placed diametrically across the top of each large tank. The direction of these girders is transversely across

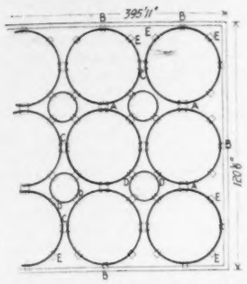


FIG. 1. PART PLAN SHOWING COLUMN AND BIN ARRANGEMENT.

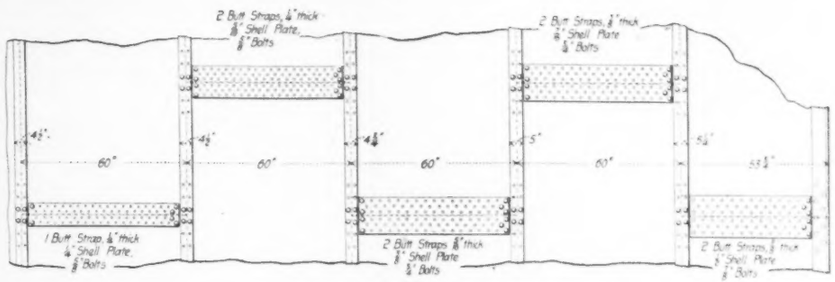


FIG. 5. DETAILS OF RIVETED JOINTS IN SHELLS OF 38-FT. BINS.

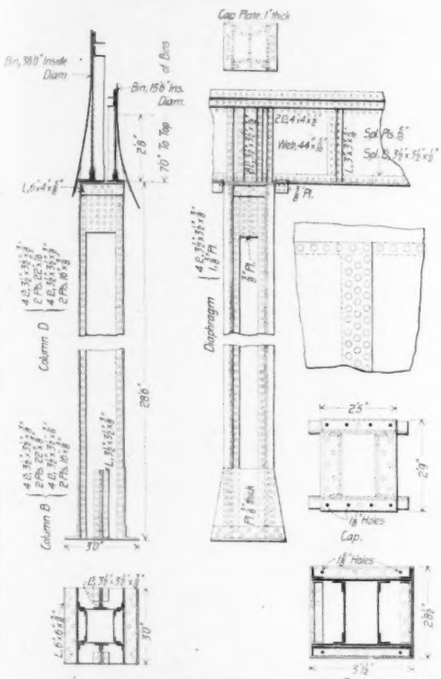


FIG. 3. DETAILS OF COLUMNS B, D AND E AND CIRCULAR GIRDERS FOR 15½-FT. BINS.

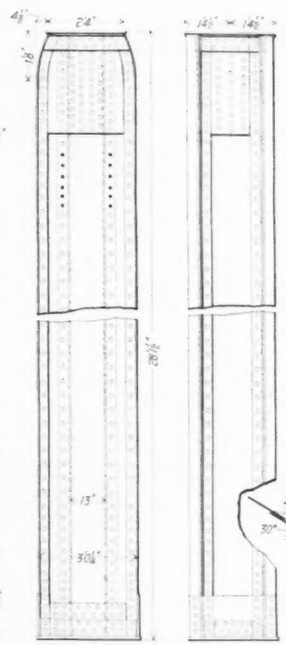


FIG. 2. DETAILS OF COLUMNS A AND C FOR 38-FT. BINS.

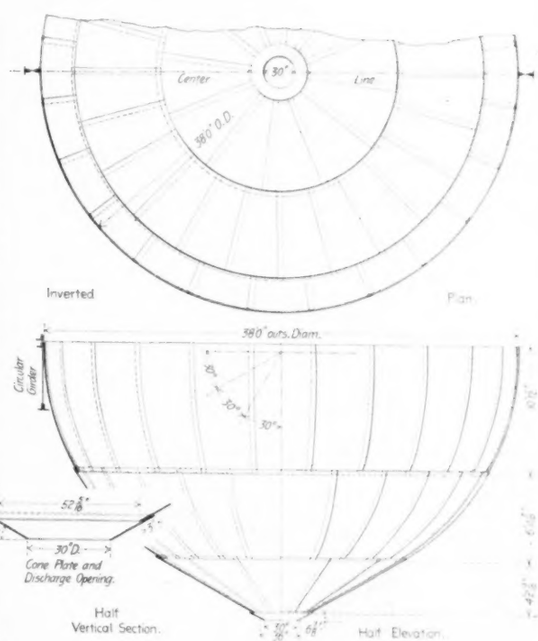


FIG. 6. HEMISPHERICAL BOTTOM FOR 38-FT. BIN.

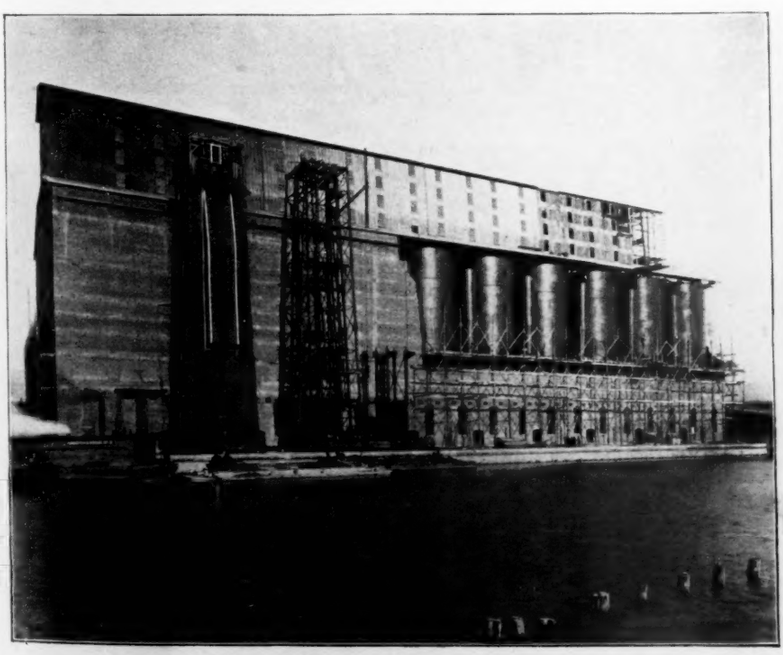


FIG. 8. GENERAL VIEW OF ELEVATOR IN PROCESS OF CONSTRUCTION.

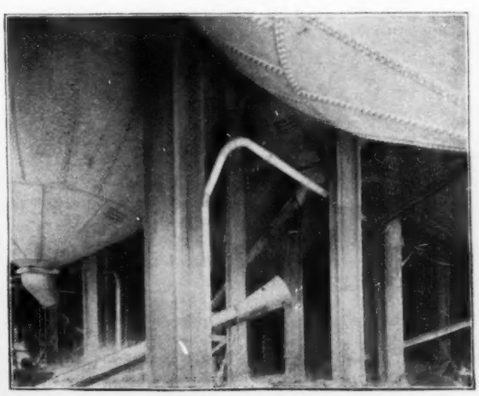


FIG. 7. VIEW OF GROUND FLOOR SHOWING BOTTOMS OF BINS.

STEEL TANK ELEVATOR "GREAT NORTHERN," BUFFALO, N. Y.

Max Toltz, Assoc.M.Am.Soc.C.E., Designing and Consulting Engineer.

Great Northern Elevator Co., Buffalo, N. Y., Owners.

the building, and they are placed inside the shells with their tops flush with the tops of the shells and the circular angle stiffeners.

The cupola floors above the main distributing floor are also composed of steel plates and I-beams, but are supported by girders carried to the columns previously described. Their general arrangement and construction are more fully described by Fig. 4. This same drawing also shows the roof framing and transverse wind bracing in sufficient detail for the present purpose. The longitudinal wind bracing is a lateral system in alternate roof panels. It may also be stated in conclusion that no provisions were made for the expansion of the steelwork below the cupola, but the cupola framing itself was provided for in this respect by sliding bearings on the brick walls.

Storage Bins.

The bins for storing the grain are 48 in number, and comprise: (1) 30 bins 38 ft. in diameter and 85 ft. deep placed in three rows of ten bins each, at a distance apart of 39 ft. 3 ins. c to c. of bins, and (2) 18 bins 15½ ft. in diameter placed in the interstices of the larger bins in two rows of nine bins each. The waste space amounts to 20% of the space inclosed by the walls. The larger bins have a capacity of 74,000 bushels each, and the smaller bins a capactiy of 11,000 bushels each. While the main parts of the bins are cylindrical, they have hemispherical bottoms tapering into a cone at an angle of 30° to the horizontal. At the apex of the cone there is a circular opening 2½ ft. in diameter through which the grain is discharged.

It may be stated here that after these tanks were constructed it was thought advisable that there should be more compartments for separate small cargoes. To supply these the eight large center bins were divided into four compartments each by hanging three additional hemispherical bottoms to their sides. Spouts with valves were arranged to fill these, and a central tube 30 ins. in diameter was run up through the apices of the four bottoms for emptying them. The discharge valves are

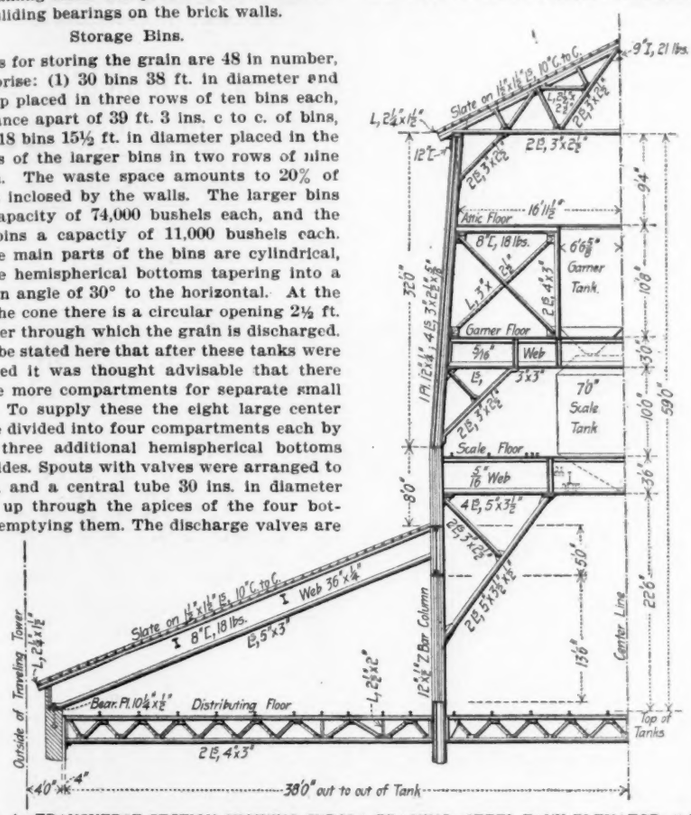


FIG. 4.—TRANSVERSE SECTION SHOWING CUPOLA FRAMING; STEEL TANK ELEVATOR, "GREAT NORTHERN," BUFFALO, N. Y.

so arranged that the operator on the ground floor can empty any bin at will.

The principle of fluid pressure in cylinders of large diameter was used in proportioning the thickness of the metal in the various rings and in the hemispherical bottom. Wheat was assumed to weigh 50 lbs. per cu. ft., and a unit strain of 17,000 lbs. per sq. in. was allowed for tension on the net area. While writers on mechanics generally agree that the strains in cylinders and spheres of equal diameter are in the ratio of two to one, yet on account of the little known mechanical forces produced by grain when in motion, it was thought prudent to make the thickness of the hemispherical bottom the same as that of the bottom rings of the cylinders.

The construction of the larger bins is illustrated by Figs. 5 and 6. The cylindrical portion of the bin is 65 ft. high and is made up of 13 rings, each 5 ft. deep, the metal varying in thickness from ½-in. at the bottom to 3-16-in. at the top. Each ring is composed of eight segments spliced together with vertical butt joints (Fig. 5). Two splice plates, one inside and one outside, are used. These plates are the same thickness as the plates spliced, except in the lower rings, where ⅜-in. splice plates are used to splice ½-in. tank plates. The rings are also spliced with butt joints, their edges being milled to assure a close, even bearing. Only one splice plate on the outside, and stiff enough to hold the rings rigidly in place, is used at these joints as the load is transmitted through the edges of the plates. All connections are made with bolts turned to a driving fit. At the upper edge of the bin, as stated above, and also at a point 15 ft. below, are attached stiffening rings of 4 × 4 × ½-in. angles.

The bottoms of the tanks are of ½-in. metal built in three rings or zones (Fig. 6). The lower zone composing the conical portion is made up of twelve wedge-shaped pieces with riveted lap joints, and the intermediate and upper zones of 24 wedge-shaped pieces. The zones are spliced together with riveted lap joints. At the 2½-ft. opening at the bottom the plates are reinforced by a diaphragm forged in a single piece to fit the cone. The smaller bins have the same general construction as those just described, but the thickness of the metal varies from 3-16-in. in the top rings to ¼-in. in the lower rings and bottom.

The manner of connecting these bins to the circular girders is illustrated by Figs. 2, 3 and 6. Fig. 7 is a view underneath the bins showing the hemispherical bottoms.

Operating Machinery.

The Great Northern elevator has a frontage of 400 ft. on the east bank of the Blackwell Canal, and a slip 80 ft. wide and 130 ft. long also gives a water frontage to the north end of the building. Grain is received from vessels by means of three movable towers mounted on wheels, and running on a four-rail track along the canal front. Fig 8 shows these towers, one of which is finished, while the other two are in the process of construction. Each tower is 20 × 30 ft. at the base, 20 ft. square at the top, and 125 ft. high.

The receiving of grain from lake vessels is effected by means of these towers, as follows: A laden vessel having been tied up at the dock, the towers are moved opposite its hatches and the marine legs dropped into the hold. Machine shovels scoop the grain from the remote parts of the hold to the boots of the elevating legs. The buckets secured to the endless rubber belt, traveling in the legs, carry their loads upward into the towers and discharge them into garners. From these garners the grain drops into scale hoppers in 200-bushel lots for weighing. This done the traps of the scale hoppers are opened allowing the contents to slide into the continuous series of hoppers extending along the front of the house. From these hoppers spouts shoot the grain down to the boots of the ten inside stationary legs. These in turn pick it up in their buckets and elevate it to the roof of the cupola, 180 ft. above.

Here its further movement depends on its condition. If clean and in good order it is spouted into one of three receiving garners, falls from there into a 1,400-bushel weighing hopper, is weighed and spouted off to an appropriate storage bin. If the cargo, however, needs cleaning, a swiveled turnhead switches the grain into other garners, whence it passes to the cleaning machines and thence by distributing spouts to the bins. There are ten of these stationary elevating legs with their accompanying garners, weighing scales and cleaning machinery in the cupola of this elevator.

For moving grain after weighing to a bin too distant to be reached by a distributing spout, belt conveyors are used. A belt conveyor consists essentially of an endless rubber belt running horizontally over terminal pulleys with supporting idlers 4 to 5 ft. apart. On this belt, which runs at a high rate of speed, the grain is spouted from a loading hopper. Although there are no marginal or other cleats, there is no spilling over the edges. The discharge from the belt is effected at any desired point by means of a device called a "tripper," which is an arrangement of four pulleys around which the belt runs so as to form a U. In this U is introduced a double-flared spout which catches the grain and switches it into a storage or shipping bin. On the spout floor of the Great Northern elevator are two such conveyors and reversible traveling trippers having belts 5 ft. wide and 750 ft. long, running at a speed of 1,000 ft. per minute each, transferring 20,000 bushels an hour.

Ample shipping facilities are provided for shipment by rail, by canal boats and other vessels, and by wagons. For car shipment there are nine shipping tanks with openings 60 ft above the tracks, from which long spouts shoot the grain into both ends of a car at once. Four sets of garners, scales and shipping tanks are provided at the slip end for loading canal boats. On the canal side vessels may be loaded from nine shipping tanks, each of which has a capacity of 3,200 bushels. There are four 1,100-bushel tanks at the south end for shipping by wagons. In shipping, the grain is drawn out of the storage bins at the apex of their bottoms by a portable spout discharging into the boot of the nearest leg. Thence it is elevated to the cupola, weighed in carload lots, spouted either directly to the shipping tank, or, if this is too far removed, onto the belt conveyor, from which it is at the right point tripped off into the shipping tank. The advantage of using shipping tanks of considerable capacity is, that weighing may go on without delay while cars or boats are shifted.

Almost as distinct a departure as building the elevator of steel was the installment of a complete electrical plant for operating the machinery. A total power of 1,300 HP. was contracted for with the Cataract Power Co., of Niagara Falls. This power is transferred from a 2,200-volt, three-phase alternating current to a current of 420 volts, two-phase. It is distributed from the switch-board to separate motors located at each leg tower, conveyor and other point where needed. Altogether there are 18 motors of the induction type all manufactured by the Westinghouse Co. The large motors are made to run at 500 revolutions per minute, and the small ones at 750. A switch-board is located on the ground floor, and the motors are so wired that one man can control all of them. The same person can communicate with operatives in all parts of the elevator by means of electric annunciators, a telephone and speaking-tubes.

Erection.

The erection of the steelwork, amounting to about 6,000 tons, had its interesting feature. The main columns, each weighing over five tons, were raised and set on end by derricks and held in place by anchor bolts. On top of them, in four sections, each weighing five tons, were placed the circular girders. In about 30 days all the bin columns and circular girders were in place. The first three cylindrical bins at the north end of the elevator were erected by means of a central mast in each tank with a tee arm extending far enough beyond

the side of the shell to hoist the plates clear of it. These had been rolled to the proper curve in the shop and after hoisting were bolted in place. This center mast was braced by a spider to the shell and was lengthened as the work progressed upward. Across the tops of these completed shells timbers were laid and a traveler with three derricks and a hoisting engine was set up. These three derricks covered the entire width of the elevator. When a set of three large and two small bins had been erected across the house the traveler was moved along about 40 ft. and another set begun. The hemispherical bottoms were riveted in segments of four plates by power riveters on the ground, and the segments then hoisted into place. The remaining rivets were then driven partly by hand and partly by power. It took about six weeks to erect the shells, and four weeks more to complete the hemispherical bottoms.

The erection of the cupola framework and the brick walls, marine towers, etc., involved no work of unusual character, and all that needs to be said further under this head is that from the time work was started on the foundations until the first cargo of grain was received only a little over six months elapsed.

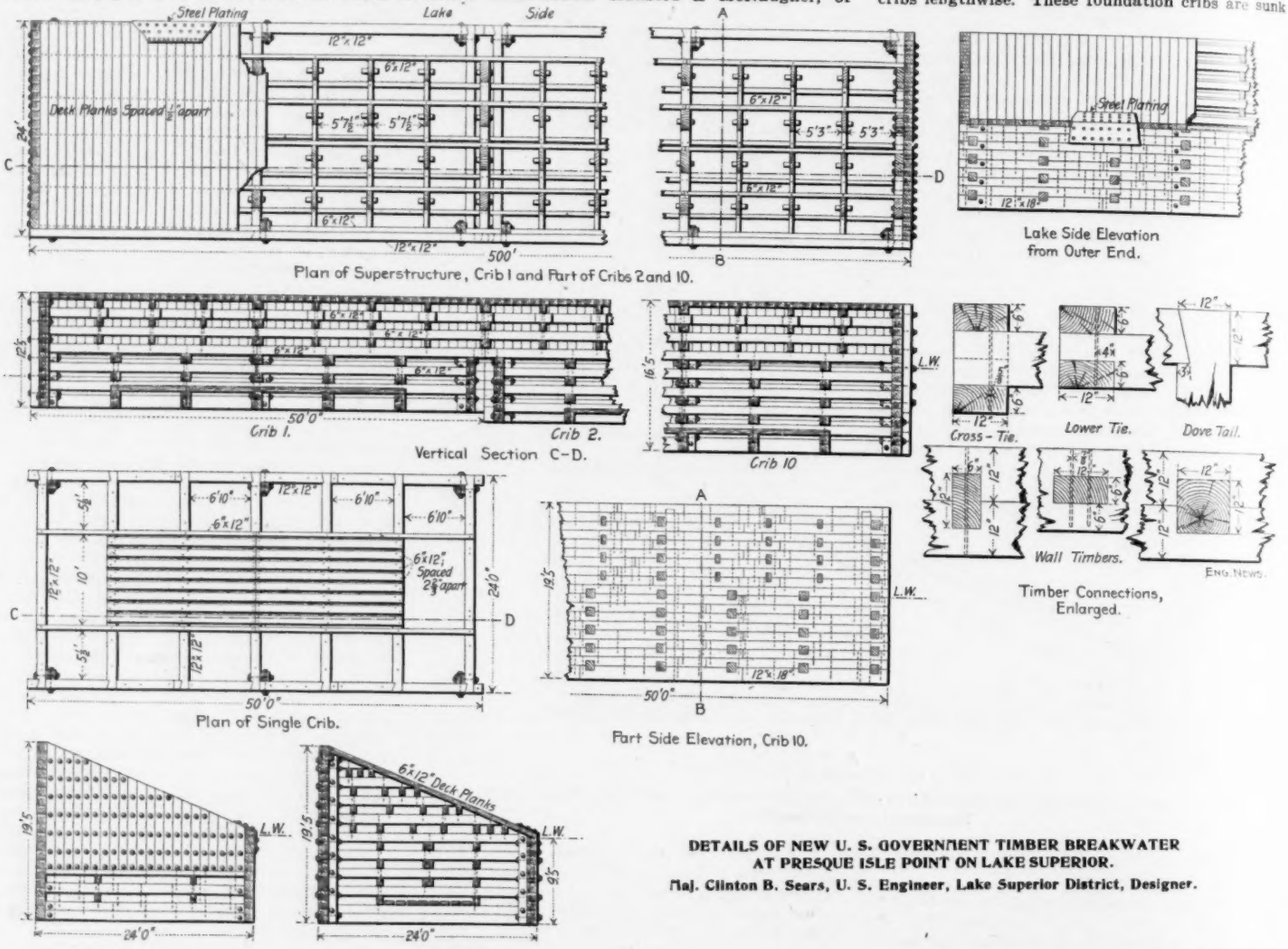
Capacity.

For those who may be interested to know, the capacities of the different bins and garners in the Great Northern elevator are given in the following table:

	Capacity, Each, bushels.	Capacity, Total, bushels.
30 bins 38 ft. diameter at	74,000	2,220,000
18 bins 15½ ft. diameter at	11,000	198,000
9 dock shipping tanks, 9¾ ft. diam.	3,200	28,800
18 track shipping tanks, 9¾ ft. diam.	1,400	25,200
8 slip end shipping tanks, 8 ft. diam.	450	3,600
4 wagon shipping tanks, 6 ft. diam.	1,100	4,400
17 garners, 13 × 13 × 6 ft.	900	15,300
10 " "	1,600	16,000
10 cupola scale hoppers	1,230	12,000
4 slip-end " "	160	640
3 tower " "	250	750
3 tower garners	300	900
Total storage capacity		2,525,890

Engineers and Contractors.

This elevator was built in the interests of the Great Northern Railway Line, and is owned and operated by the Great Northern Elevator Co., of Buffalo, N. Y., of which Mr. W. C. Farrington is President and General Manager. The general and detail plans of the steel construction were designed by Mr. Max Toltz, Assoc. M. Am. Soc. C. E., Bridge Engineer of the Great Northern Ry., who acted in the capacity of consulting engineer during the construction. Mr. Newcomb Carleton, of Buffalo, N. Y., as consulting electrical engineer, designed the electrical plant, which was installed under the direction of Mr. Albert Vickers, electrical engineer. The elevator machinery was designed by Mr. D. A. Robinson, of Chicago, Ill., who also had charge of the entire construction. Hallsted & McNaugher, of Pittsburg, were inspectors of steelwork. The contractors for furnishing the main body of the steelwork were the Riter-Conley Co., of Pittsburg, Pa., Mr. Robert A. McKean being their Chief Engineer. The Penn Bridge Co., of Beaver Falls, Pa., furnished the material for and erected the marine towers.



DETAILS OF NEW U. S. GOVERNMENT TIMBER BREAKWATER AT PRESQUE ISLE POINT ON LAKE SUPERIOR.

Maj. Clinton B. Sears, U. S. Engineer, Lake Superior District, Designer.

BREAKWATER AT PRESQUE ISLE POINT, MARQUETTE, MICHIGAN.

By W. H. Hoyt.*

Presque Isle Point extends in an easterly direction from the south shore of Lake Superior on the upper peninsula of Michigan. Besides being the terminus of the Lake Superior & Ishpeming Ry., with its extensive ore shipping facilities, and the location of a large sawmill and dock, the town is directly on the route of all south shore travel on the lake. At the last session of Congress the harbor was designated as a harbor of refuge, and an appropriation was made for constructing a breakwater from the end of the point out into the lake. This work came under the United States Engineer Officer for the Lake Superior district, Maj. Clinton B. Sears, and the plans for the entire structure were designed by him. These plans are, it will be seen, somewhat novel, particularly in the construction of the out-shore face of the breakwater, which has a sloping surface or deck.

As constructed thus far the breakwater consists of ten foundation cribs 24 ft. wide and 50 ft. long, which vary in depth from 6½ ft. to 9½ ft., to allow for the slope of the lake bottom away from the shore. These cribs are framed with solid timber walls of 12×12-in. timber strongly braced together with 12×12-in. crossties, 24 ft. long, running from wall to wall and dove-tailed at the ends. Timbers, 6 × 12 ins. by 24 ft., tie the walls of the cribs lengthwise. These foundation cribs are sunk to place by means of temporary guide piles, with block and tackle, and are drawn up close to adjoining cribs with turnbuckles. They are set accurately to line and with their tops level and when placed come, on an average, within a foot of the bottom, which is a smooth, water-worn sandstone ledge. The four center pockets contain a floor for holding stone to sink the crib and when it is in place the other pockets are filled with rock of such size that it will run under the wall and give a solid foundation to the work.

On top of these cribs the superstructure is framed continuously. The longitudinal timbers extend from one crib to the next and are securely drift and screw-bolted to the posts and cross-ties. The deck is set at an angle of approximately 22° to the horizon, with the front edge to low water datum and the upper or rear edge 10 ft. above low water datum. The deck timbers are single pieces, 6×12 ins. × 25 ft. 1 in. long, lying lengthwise with the slope, with ½-in. open spaces, and are securely spiked to stringers with ½×12-in. boat spikes, twelve in each timber. The lower corner is protected from driftwood and ice by a steel plate 0.18 in. thick, extending 2 ft. 6 ins. up the deck, and the same down the wall. This plate is securely

*U. S. Engineer Office, Duluth, Minn.

spiked on with three rows of ½×6-in. spikes on top and two rows of ½×12-in. spikes on the wall.

All timber is first-class white or Norway pine. In the cribs, up to 2 ft. below low water datum hemlock is used. All intersecting timbers are drift-bolted with ⅞-in. round drift bolts, 1 in. less in length than the three intersecting timbers. The drift-bolts are slightly rounded at one end, and the holes are bored ⅛-in: less than the diameter of bolt, so that they drive with a very tight fit. In the walls all drift-bolts are 35 ins. long, and average about three to each 16-ft. of 12×12-in. timber. Every other wall timber and every 12×12-in. cross-tie is bolted with ⅞-in. screw bolts to the upright posts, extending from the bottom to the top of the structure. The outer and inner ends of the breakwater are well protected by 12×12-in. upright timbers extending from 4 ft. below low water datum to the top of the deck and securely screw-bolted to both the foundation cribs and the superstructure.

The outside of the breakwater is well rip-rapped with stone, both in front and behind, up to at least 3 ft. above the bottom of the cribs. This rip-rap serves to keep the filling of the cribs from washing out and to prevent any movement. All rip-rap stone must weigh at least 1½ tons. All the stone used in the breakwater is of a very hard, heavy quality, weighing 166 lbs. per cu. ft. This stone is packed in very closely up to the under side of the deck, and small stone, well hammered in, are used to smooth up the top before laying the deck timbers.

The work as thus far carried out, was built under the supervision of Mr. Clarence Coleman, U. S. Assistant Engineer for the Marquette District. The contract price for the 500 ft. was approximately $16,000, or $32 per lin. ft. of breakwater. The total amount of timber used was 482,690 ft. B. M., ranging in price from $11 to $14 per thousand for pine, according to length, and $8 per thousand for hemlock, delivered at the site. The total amount of iron used was 53,600 lbs. in drift-bolts, screw-bolts, spikes and plates. There were 1,200 cords of stone used for filling and rip-rapping, all of which was towed on scows from the quarry, about 4 miles away. Wages averaged about $1.75 per day. The work is in a very exposed location, and a light breeze from almost any direction soon causes a heavy sea, making the item of risk a very important factor.

With the light storms that have already taken place this fall the action of the waves on the sloping deck has been very satisfactory. They do not deliver the heavy blow given a vertical surface, and the pounding action due to the breaking of the wave is very largely eliminated by the receding water of one wave striking back into the incoming wave at the toe of the slope. The action of the receding under currents can be observed some distance out in front of the breakwater as they very largely destroy the heavy billows and make a choppy sea.

BACK-FILLING TRENCHES.

Two interesting papers on back-filling, followed by lengthy discussions, were presented before the New England Water-Works Association last winter and have been printed in the "Journal" of the association for March. The first paper was by Mr. E. A. W. Hammatt, of Boston, who cited the following regarding the shrinkage of earth in back-filled trenches:

Some authority states that the average shrinkage of various earths is about as follows:

Gravelly earth	8%
Yellow clayey earth	10 "
Light sandy earth	12 "
Puddled clay	25 "

If this is correct, we should have in a trench 5 ft. deep and 2½ ft. wide, giving 12.5 cu. ft. per running foot, a shrinkage in the case of

Gravelly earth equivalent to a depth of			0.40 ft.,	or 1.00	cu. ft.
Yellow clayey earth	"	"	0.50 "	1.25	"
Light sandy earth	"	"	0.60 "	1.50	"
Puddled clay	"	"	1.25 "	3.12	"

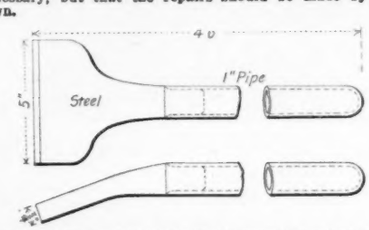
Taking into account the average thickness of water pipe of the various sizes as given by the tables of certain foundries, we find that per foot, the following is the number of cubic feet of space occupied by the pipe:

6-in. about	0.27 cu. ft.	12-in. about	0.96 cu. ft.
8-in. "	0.44 "	14-in. "	1.29 "
10-in. "	0.69 "	16-in. "	1.66 "

From the above it would seem that when the pipe laid are not larger than 12-in., we ought to be able in the average water pipe trench, to get back all the material excavated and leave no ridge, and that even with 16-in. pipe the surplus ought not to exceed about 140 cu. yds. per mile of line, or 2.6 cu. yds. per 100 ft. It would indicate also, that with 6-in. pipe, it would be possible to refill all the excavated material and leave about 4 ins. in depth of trench to be refilled by borrowed material—or with 8-in. pipe about 2 ins. How often is this done? Different materials require different treatment in order to get the best results in back-filling. Therefore, I question the advisability of too much detail as to methods in drawing specifications.

Mr. Hammatt believes that in general the material can be put back better with a liberal use of water than by dry ramming; also that better results would be secured by the use of lighter rammers, say of 5 or 6 lbs. weight, instead of 20 to 25 lbs., the lighter being lifted higher and giving less fatigue to the laborer than the heavier one. He concludes his paper as follows:

To sum up, I hold that back-filling should be done in such a manner that where the pipe does not exceed 12 ins. in diameter, all the material excavated shall be put back into the trench, and the surface left smooth and with no appreciable ridge, care being taken that the original character and quality of the road surface is restored. When larger pipes are laid it would be comparatively easy to fix the amount of surplus material which would be allowed, which surplus should not contain any of the original surfacing stock—which should all be used to resurface the trench. In no case should the material used in back-filling be allowed to be spread wider than the size of the trench excavated, as if this is done, shoulders which will retard or prevent surface water from reaching the gutters, are unavoidable, and they must eventually be picked down and removed. This is more expensive than to refill a slight depression, and usually means the carting off of road metal, which ought not to be removed. I also believe that instead of requiring the contractor to keep the trenches in repair for six months, a certain percentage of the contract price should be retained for that length of time for the purpose of making repairs which may become necessary, but that the repairs should be made by the town.



Special Rammer for Use in Back-Filling Trenches for Large Pipe.

The second paper was read by Mr. E. H. Gowing, also of Boston. Mr. Gowing laid stress on the desirability of discriminating between rough country roads and well-made streets in writing the back-filling clauses of specifications. He also called attention to the well-known fact that most contractors do not expect to be compelled to carry out this part of the specifications at all literally. Some engineers have recently called for alternative bids, one for ordinary back-filling and another for putting all the material back and leaving the filled trench level with the original surface. A marked difference in the bids resulted. This plan allows the water commissioners or other local authorities to decide whether they wish extra good back-filling work done or whether they are willing to accept poorer work for the sake of economy. It also avoids the risk of paying for the best kind of back-filling, but actually getting poor work.

Mr. Gowing recommended a special rammer for use in packing dirt beneath large pipes, something like those used for tamping ties in railway work. Such a rammer is shown by the accompanying illustration.

The discussion on these papers brought out the usual diversity of opinion and practice exhibited whenever and wherever the subject of back-filling trenches is under debate. It seemed generally agreed that while it is possible to put all the material back in trenches, few contractors expect to be compelled to do it; and they bid accordingly and do not carry out the specifications. In populous and well-paved or macadamized districts it was pretty generally agreed that the dirt should all be put back, while in small country towns the extra expense involved, coupled with the original bad condition of the roads, would not warrant such attempts. There was also a unanimity of opinion that the specifications should call only for what would be insisted on, and that where different grades of work are permissible bids should be secured accordingly. In some localities road scrapers may be used for back-filling. The consensus of opinion seemed to favor quite thin layers, 4 to 2 ins., where reliance is placed on tamping.

A number deprecated tamping the surface layer, only, as in this way a hard crust is formed which delays surface settlement and may give rise to underground cavities, followed by sudden depressions or breaks in the surface which may result in damage claims against town or contractor. At best surface tamping affects the filling for a short distance below the surface. One instance was cited of the use of vertical pipes, sunk in the loose dirt and filled with water from hose, for settling the trenches. These pipes received water until the dirt became saturated, then were moved to a new position.

The relative desirability of using water or tamping depends largely upon the availability and cost of water. Oftentimes water is not readily available, or the contractor must pay what he considers to be an excessive price for it. On the other hand, few contractors will put on one tamper for every shoveller, which some of the speakers thought essential. If this was required, contractors might be more ready than now to use water even under difficulties or at high cost for the water. An objection raised against flushing, or using water to settling trenches, was that it makes the dirt shrink away from the sides of the trenches.

The general impression derived from the whole discussion is that in no other class of engineering work is there more diversity of opinion and practice, and greater need of honest work, and yet the underlying principles are simple and easily followed wherever there is a determination to secure and a willingness to pay for good work.

NOTES FROM AMERICAN BRIDGE SHOPS.

IV.

Riter-Conley Co., Pittsburg, Pa.—The old boiler and plate works of this company are located in Pittsburg, but recently the company has erected a plant for structural work in Allegheny City, just across the river. On account of their special tools for heavy plate and tank work, however, the old works are quite as interesting to the engineer as the more modern plant. Together the two plants occupy 138,000 sq. ft. of floor space besides about 5 acres of yard room, and about 600 men are employed.

In the old works the machines are adapted only to plate work, and comprise rolls, punches, drills, riveters, etc., hydraulic riveters of 40 and 60 tons capacity being among the last named tools. These powerful machines, together with the bending roll for plates 21 ft. wide and 1½ ins. in thickness, do most, perhaps, to impress one with the heavy character of the work which the firm does, but two of the special punches and the hydraulic flanging press are hardly less impressive. One of these punches is designed for punching all the holes in the end of a tank plate at one stroke. This punch takes in a plate 8 ft. wide, and by simply changing the dies will punch as many holes at once up to 60 at one stroke as may be desired. The second punch is for punching the holes along the two opposite sides of tank plates, and can be adjusted to plates from 4 ft. to 6 ft. wide. A spacing table is fitted to this punch so that the spacing of the holes is accurately controlled at any distance apart desired.

At the time of the writer's visit the shops were busy on an order of twenty-four 25-ton, two 40-ton and eleven 45-ton ladles for the Carnegie Steel Co. The accompanying view, Fig. 1, shows four of the 45-ton ladles ready for shipment, and Fig. 2 shows their construction in somewhat more detail. The shells and bottoms of these ladles are made of flange steel, the riveting being done under a pressure of 60 tons. The bands are shrunk onto the shells in much the same manner that the hoops are shrunk on a modern built-up gun. The trunnions are steel castings, machined and drilled for the connections with the shell. In closing the reference to these ladles it may be stated that the two larger sizes are for the Homestead Works of the company and the 25-ton ladles are for the Duquesne Works.

In the structural works the company confines itself almost entirely to the construction of steel frame shop buildings, doing very little bridge work or work on fireproof steel buildings. The machinery here is modern, but of ordinary size and

capacity. The shops are well equipped with traveling cranes.

Pittsburg Bridge Co., Pittsburg, Pa.—As indicating the increasing tendency in America to abandon pin connections for small bridges, it may be noted that this company has recently added to its list of standard structures a complete line of riveted bridges, and is pushing their sale instead of the older pin connected structures for corresponding spans. This departure in no sense indicates that pin connections are growing into disfavor for heavier structures. In fact the company has recently completed a pin connected bridge for electric railway traffic, which, so far as the writer knows, is the longest span electric railway bridge

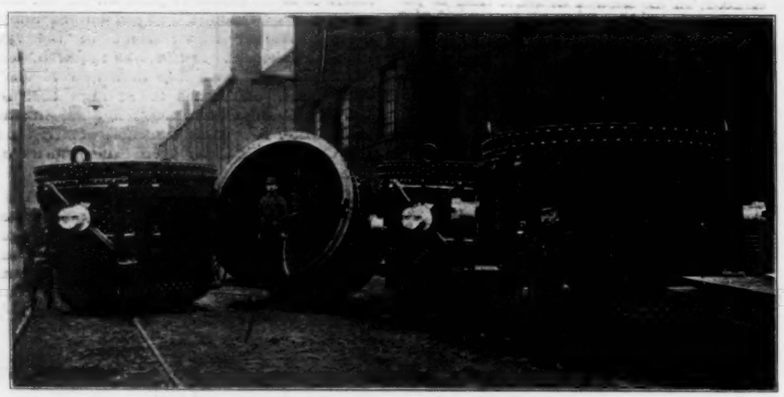


FIG. 1.—VIEW OF SHIPMENT OF 45-TON LADLES FOR HOMESTEAD WORKS OF THE CARNEGIE STEEL CO.
The Riter-Conley Co., Pittsburg, Pa.

ever built. This bridge has one 252-ft. span, one 489-ft. span, one 517-ft. span, and 1,100-ft. of viaduct. It is designed for a double-track electric railway line, the trusses being placed 22 ft. apart.

A planer which the company has recently installed for finishing the bevel tracks of swing bridge turntables is the most complete machine of this character which the writer has seen. The table of this planer consists of a set of radial girders attached to a circular girder and covered with steel plates. This table is pivoted to a steel post 10 ins. in diameter, and is revolved around this post as a center by means of power applied by worm gearing to a rack on the bottom outside edge of the circular girder. The inner end of the tool arm slides on the pivot post and the outer end on a similar post set up outside of the circular girder, a screw at each post serving to adjust the height of the arm. The tool head slides on this arm and can be adjusted to plane any bevel desired. The total diameter of the circular table is 32 ft.

Chester B. Albree, Allegheny, Pa.—While the construction of railings and ornamental iron work for bridges calls for none of the heavy tools nor for the powerful hoisting and conveying machinery found in the bridge shop proper it has a distinctive interest of its own. First of all the ornamental iron work shop is a smithy, the process of punching, drilling and riveting being of very ordinary interest compared with the blacksmith work and the power forging and stamping. A cursory glance at almost any bridge railing will show how this must be so, but for a concrete example we may take the hand railing for the Harlem River Speedway in New York city, Fig. 3, about three miles of which this company is building. The ornamental forms used in this railing are scrolls, rosettes and twisted iron.

Starting with the rosettes first, it will be seen that these are simple ornamental castings, which, in addition, serve the structural purpose of binding together and covering the ends of the scrolls and twisted bars which converge at this point. In some cases wrought metal is used for these rosettes, when, of course, they are stamped in a press to the proper shape and ornamentation. The manufacture of the scrolls is practically all hand work, and this is true not only of the simple forms in this railing, but of the more elaborate hammered leaf-scrolls. Taking one of the four larger scrolls which radiate from the center rosette, for example; the flat steel bar is first cut to length and the rivet hole at the inner end is accurately punched. The bar is then heated and given an initial bend by the apparatus shown in the accompanying sketch A, Fig. 4, and finally bent by hand around a mandrel to the final form as indicated by sketch B on the same engraving. The twisted bars are manufactured without heating, the work being done on a machine much like a bolt threading machine.

The stationary head of this machine is simply a vice jaw, while the movable head has a rectangular opening adjusted to fit the bar loosely. The bar cut to proper length is inserted in this rectangular hole and clamped in the vice jaw, when the revolution of the movable head gives it the proper twist. As the revolution of the movable head is quite slow, while the vice jaw has a quick-acting clamp motion, an expert workman finds it unnecessary to stop the machine for removing and inserting the bars. The idea of fitting the bar loosely in the movable head is to allow for the shortening due to twisting.

To fasten the scrolls and other members together both clamps and rivets are used. A form of clamp which these shops have found to be very easily and quickly adjusted, and at the same time very secure, is the tongued and grooved clamp shown by sketch C, Fig. 4. This clamp is cut and bent cold to a U-shape, and then heated and adjusted by hand. While the riveting in this class of work is not often of a heavy character, it has in many cases to be done in very confined spaces and requires an unusual flexibility of the riveting machine. This led to the development by Mr. Albree of a special form of compressed air riveter, which he some time ago placed on the general market.

One of these riveters which embodies the distinctive characteristics of them all is shown by Fig. 5. This machine was built for the Risdon Iron & Locomotive Co., of San Francisco, Cal., and will be used by them for riveting Fox corrugated flues into marine boilers, for which the jaws extending out beyond the main body particularly fit it. The chief novelty of the machine, however, is the universal bail. This bail is semicircular, and secured to the machine by trunnions passing through the actual center of gravity. This construction, it will be seen, allows the machine to be held at any angle in any plane. In designing this machine the center of gravity had to be exactly determined, and it may be of interest to note that when the machine was completed, ready to drill the trunnion holes, and hung on temporary pivots, they came within 1-16-in. of the calculated position. This universal bail, it will be understood, is not peculiar to this particular machine, but is applied to all riveters built by Mr. Albree when ordered.

In conclusion it may be noted that the railing for the Harlem River Speedway, illustrated by Fig. 3, is made entirely of soft steel and weighs about 60 lbs. per yd. It was designed by Prof. Wm. H. Burr, M. Am. Soc. C. E., of New York, and the contractor for erection is Mr. R. H. Hood, St. Paul Building, New York.

Schultz Bridge & Iron Works, Pittsburg, Pa.—The works of this company are located at McKees Rocks, on the Ohio River, and comprise a yard and stocks for manufacturing steel barges, as well as the bridge works proper, which have a capacity of about 600 tons per month. The main building, which houses the blacksmith, machine and truss shops, stands in the angle of a Y-track; the angle of this Y forming the loading yard, while the unloading yard is at the opposite end of the building and is reached by one of the tracks of the Y, the other track of the Y being depressed and used for shipping purposes only. The method of unloading the raw material here is by a derrick traveling on a yard track parallel to the unloading track of the Y. From the unloading yard through the shop to the loading yard the material has a travel of only 350 ft., and it is to this short travel of the material and the very compact arrangement of the different shops and tools under one roof that the company claims is due its ability to compete with the larger and more modern bridge plants. In the matter of tools and machinery the shop is adequately equipped for the work it has to do, but beyond this there call for no particular notice. At the time of the writer's visit, the shops were fairly busy on building work and the prospects were stated to be favorable for a good season's business.

Fort Pitt Bridge Co., Pittsburg, Pa.—These works are quite young compared with the other well-known bridge shops about Pittsburg, having been in operation only about two years, but they comprise a number of modern buildings located on a tract of about 6½ acres at Cannonsburg, some 20 miles from Pittsburg, and are receiving a fair share of the bridge business coming to this district. Owing to their recent construction, the company's shop buildings are more modern in design and equipment than many of the older Pittsburg shops, being provided with electric traveling cranes and compressed air hoists, and with modern machine tools of the ordinary kinds. The hammer and forge shop is fitted for manufacturing iron eye-bars, and altogether the several shops have a capacity of between 700 and 1,000 tons of finished work per month.

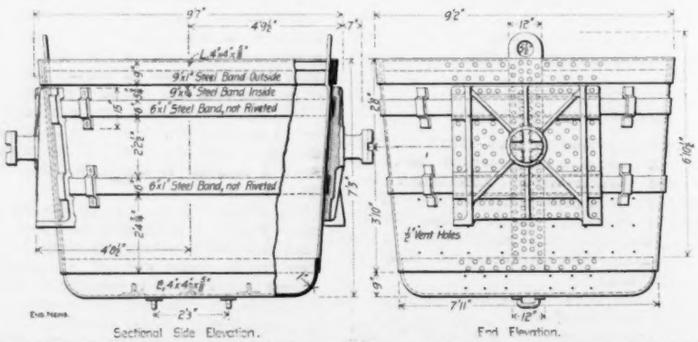


FIG. 2.—DETAILS OF 45-TON LADLES FOR HOMESTEAD WORKS OF THE CARNEGIE STEEL CO.

Penn Bridge Co., Beaver Falls, Pa.—The visit to this company's plant found all departments very busy on building work, and the writer was told that for some time past the greater part of the output had been building and shop work rather than bridge work. In the arrangement of their

yard space and shipping facilities the company is well situated, but the shop building is a relic of older days, and has the usual lack of head room and other inconveniences of the shop building of 20 or 30 years ago. One building provides for all classes of work. The yards occupy a strip of land parallel to the tracks of the Pittsburg, Ft. Wayne & Chicago R. R., and a depressed switch track runs along their outer edge. Traveling bridge

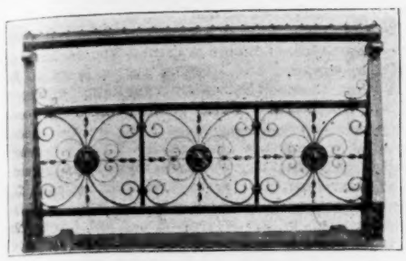


Fig. 3.—Railing for Harlem River Speedway, New York, N Y. Chester B. Albree, Allegheny, Pa.

cranes straddle this switch track and a line of storage skids and load and unload all material. From the skids push car tracks deliver the material to and from the shops. The shops have a total capacity of about 500 tons per month, and the writer was informed that during the past year they had been pushed to their full capacity to fill the orders taken.

MOTOR-WAGONS FOR THE USE OF STREET CLEANING DEPARTMENTS.

An interesting report on the use of "Motor Dust-Vans" was recently made by Mr. T. W. E. Higgins, Assoc. M. Inst. C. E., Surveyor to the Vestry of the Parish of Chelsea, England. The report was reprinted in the London "Contract Journal" for March 23, 1898, from which the following has been taken:

Mr. Higgins was instructed to report on the advisability of buying 15 motor dust-vans for the use of his vestry. In the opening part of his report he urges that the municipal body in charge of streets ought to do what it can, by example and otherwise, to encourage the use of motor wagons because lessening the number of horses in use decreases street dirt and the wear of pavements. After some remarks regarding horse power, and traction, and descriptions of the various motors now in use for motor-wagons, Mr. Higgins continues as follows, except for slight abbreviations:

Conditions to be Observed in Submitting Estimates.—In order to obtain the necessary estimates I wrote to eleven firms asking if they were prepared to submit estimates to the Vestry for motor dust-vans. These vans I specified were each to contain 6 cu. yds. of refuse, which would not weigh more than four (long) tons; they were to be worked in accordance with the Locomotives on Highways act of 1896, and would be required to tip the refuse over a shoot. From the replies I received it seems evident that a vehicle of the size I specified is rather beyond the capacity of the ordinary electric motor or oil-engine. There do not at present seem to be any firms making electrically-driven cars of the size we require. The makers of electric motor-cars seem to be directing their attention more to light passenger vehicles than to heavy vans for business purposes. The Daimler Motor Co. and the Great Horseless Carriage Co., of Coventry, both makers of oil-motors, write that at present they are unable to quote for so large and heavy a type of car as would be required for the purpose we have in view. Messrs. Roots & Venables, of Westminster Bridge Road, will build a dust-van driven by an oil-motor of 6 HP., geared to run at any speed not exceeding six miles an hour, and capable of carrying a load of 1½ (long) tons, for $1,820. The engine would be driven by ordinary paraffin, and the cost of fuel would be less than 6 cts. per hour. This van is, I think, too light for the work required. If a van of larger capacity is used the time spent in traveling backwards and forwards to the wharf to tip will be reduced by one-half. Five firms have submitted estimates and specifications for steam motor-vans, as follows:

Proposals Received.—The Lancashire Steam Motor Co., of Leyland, will build a steam-motor dust-van for $1,550. The tip van to carry 6 cu. yds. of dust, the weight of dust not to exceed four (long) tons. The body of the van to be made of ash supported with ironwork. The underframe to be channel steel filled up with oak. The engine and boiler to be placed alongside the driver's seat, within a covered shelter for the driver. The engine to be a compound steam engine of about 14½ HP., to have a speed of four miles an hour; and the boiler to be composed of patent copper conical tubes, and to work at 200 lbs. per sq. in. The firing is done by a patent automatic oil-firing apparatus, which keeps the working pressure steady; it is quite independent of the driver's attention after he has once lighted the burner. The consumption of oil does not exceed two gallons per hour when in full work. The commonest paraffin oil is used. The Lancashire Steam Motor Co. are the makers of steam road vehicles and lawn mowers.

Messrs. T. Coulthard & Co., of Preston, will build a steam-motor dust-van for $1,650; if the twelve vans are ordered at the same time there will be a reduction of 5%. The tip-van is to carry six cu. yds. of dust, the weight of dust not to exceed four (long) tons. The effective horse-power of the engine is to be under ordinary conditions 9 HP., but when high-pressure steam is used in both cylinders 18 HP. A patent distribution valve will be used, which will admit of the steam being regulated between "no load" and "full load," the whole operation being performed with one lever. The engine is fully protected from dust, and can easily be cleaned. The boiler is of the water-tube type, oil fired; all the tubes are straight and accessible. The tip-van is to be built by the Gloucester Carriage Co. and is to be provided with their patent tipping gear. The engine and boiler will be placed alongside the driver's seat, and the driver will be protected by a covered shelter. The consumption of oil—ordinary lamp oil—will be less than 15 gallons during the day's work. Messrs. Coulthard & Co. have a van in use at Preston which is used for carrying coal and heavy goods.

Messrs. Toward & Co., of Newcastle-on-Tyne, will build one steam-motor dust-van for $2,085. The engine and boiler would be placed under and alongside the driver's seat within a covered shelter. The engine would be a compound steam-engine, fired with coal or coke, having an intermediate shaft geared for five and three miles per hour. The road wheels would be of steel with iron tires. The tip-van is to contain about 6 cu. yds., the weight of dust not to exceed four (long) tons. The approximate cost of working, according to the makers, would probably be: Driver, $4 to $5 per week; coke or coal, $1 to $1.20 per week; waste stores, 60 to 80 cts. per week; total, $5.60 to $7.00. Messrs. Toward & Co. have built a steam-driven parcels van which is now in use in the North.

The Liquid Fuel Engineering Co., of East Cowes, Isle of Wight, will build a steam-motor dust-van for $2,545, but

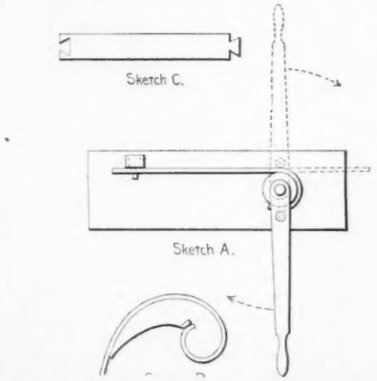


Fig. 4.—Sketches Showing Manner of Shaping Scrolls for Ornamental Railings.

if the order is given for three vans at the same time the price to be $2,300. The tip-van is to carry 6 cu. yds. of dust, or from three to five (long) tons of rubbish. It is to be built of suitable seasoned wood, the frames to be of best channel iron. The engine and boiler to be placed in front of the van. The engine to be a compound steam-engine, and the vehicle is to have a speed of from five to six miles an hour, the boiler to be of the water-tube pattern, ordinary paraffin oil to be burned, and the firing is automatically regulated by means of the steam pressure in the boiler. The van is fitted with a steam ejector whereby dustbins could be steamed out. The Liquid Fuel Engineering Co. are the makers of the steam-motor road train which runs between Cirencester and Fairford.

The Steam Carriage & Wagon Co., Limited, of Chiswick, will build a steam-motor dust-van for $3,240. The tip-van is to contain six cu. yds. of dust, and will carry a load of three (long) tons up an incline of 1 in 20 on ordinary macadam roads. The main framing is to be of steel, as also are the wheels. The engine and boiler will be placed alongside the driver's seat, and will be protected by a covered shelter. The boiler will be of the Thorneycroft water-tube type, with special arrangements for the control of steam and silent blowing safety valve, the engine (a compound reversing one) being enclosed in a dust-proof and oil-tight casing. The Steam Carriage & Wagon Co. are the makers of the two motor dust-vans now in use at Chiswick, which collect an average of 20 cu. yds. of refuse per day with a consumption of 224 lbs. of steam coal.

The price of these vehicles vary considerably, and an inspection of the plans and specifications submitted does not show sufficient reason for such a great difference, but the two lowest estimates are very close. A sum of $1,550 or $1,650 is not much to pay for a motor-van of this capacity, and if a thoroughly reliable motor can be obtained at that price, I think the Vestry would be wise in purchasing one on the understanding that if it worked to their satisfaction for six months they would obtain more motor-vans from the same maker.

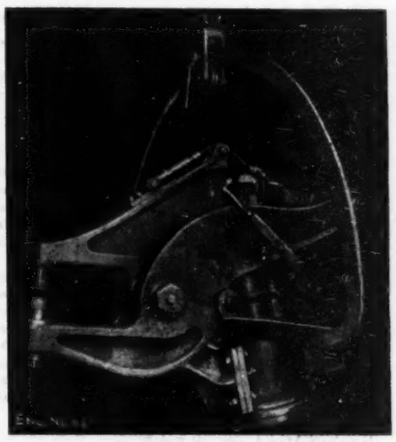


Fig. 5.—Riveter with Universal Bail. Chester B. Albree, Allegheny, Pa.

Mr. Higgins assumes that two horses and horse vans would be required to do the work of one motor van. He estimates horses at $340 each and vans at about $240, so that the capital required for the motor vans would be $485 more than for the horse vans. But this would be offset, he thinks, by the lower cost of operating the motor wagons, one less driver, though at a higher price, being required, and there being no horses to feed and shoe. The high estimated value of horses here given should be noted in considering these figures:

In conclusion, Mr. Higgins recommends that the two lowest bids be given careful consideration, but adds that he cannot recommend acceptance of either of the two bids until he has seen their vehicles at work so as to satisfy himself that their arrangements for burning liquid fuel are quite satisfactory.

THE COLT AUTOMATIC GUN, Browning patent, made by the Colt's Patent Fire Arms Mfg. Co., of Hartford, Conn., is described as follows: In caliber it can be manufactured to fit any kind of rifle ammunition desired, and be adapted to mounts suitable for army, navy or police purposes. The gun weighs about 40 lbs., and at 200 yds. range 100 consecutive hits have been made in 16 seconds, and 8,000 rounds have been fired without fouling or a single hitch showing wear or weakness. The gun consists of one very heavy barrel attached to a breech casing containing the mechanism for charging, firing and ejecting the cartridges. The cartridges are fed automatically from belts coiled in a box attached to the breech, and this box contains 100, 250 or 500 cartridges and may be quickly removed and replaced with a full one. The automatic action is the resultant of the pressure of the powder gases in the barrel, exerted after the projectile has received its maximum velocity. On pulling the trigger the shot is fired, and after the bullet has passed a vent near the rear of the barrel, the powder gases expand through this vent and act upon a piston and gas lever, which in turn operate the breech mechanism, open the breech, eject the shell, feed in another cartridge and close and lock the breech. If the trigger is still held back the charge is fired and the operation automatically repeated at the rate of 400 shots per minute, or as long as cartridges are supplied. A safety lock engages the hammer, when required, and prevents it from striking the firing-pin. The hammer of the gun also acts as a piston for an air-pump and forces a strong jet of air into the chamber and thus removes all residue or unburnt powder. The gun barrel is so heavy that it will stand the heaviest charge of nitro-powder, without disturbing the accuracy of fire by vibration, and it needs no water-jacket for cooling.

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The use of steel ties for railway track is a matter of very live interest in European and some other countries, where owing to conditions of climate, or of the relative cost of steel and wood, the use of steel ties effects a direct financial economy, as well as a general improvement in permanent way. The subject is perhaps not of immediate interest in this country, as timber is still comparatively plentiful, and the use of steel tie-plates as tie preservatives has made the cheaper and inferior qualities of timber available for railway service, while the preservation of ties by the employment of chemical treatment has not yet been developed to any large extent. Nevertheless, in view of the great and steady demand for timber for railway and other purposes, and the reduction in the supply by consumption and by fire, it seems probable that the price of wooden ties will increase considerably within a few years. This, with a reduction in price of steel, may introduce in this country approximately the same conditions which have led to the extensive introduction of steel ties in Europe, and therefore, as we have pointed out before, it is well now for far-seeing railway men to consider the conditions of and experience with such ties on European railways, with a view to the possibilities of their future introduction in this country. In another column we give the general tenor of a report on the experience of the Gothard Railway (Switzerland) with metal ties, up to the present year, and the information given is of a very instructive and interesting character. Metal ties have been used on that road since 1882, and to a practical extent since 1885, the steel ties now representing 70% of the ties in the main track. The results have been entirely satisfactory in point of cost, durability and cost of maintenance, even when compared with oak ties protected by tie-plates. It is expected that the ties will last as long as the rails, and the advantages due to this, in eliminating the expense and disturbance due to tie renewals, are very evident. Furthermore, they are actually more economical than the wooden ties (with tie-plates), are practically uninjured by rust (except in long tunnels), and do not crack or break, even at the bolt holes. The ties now used weigh 163 lbs. each, and are 8 ft. 10 ins. long, with a maximum thickness of 15-32 in. The figures and statements taken from the report are worth careful consideration, and it is to be borne in mind that there is a combination of very severe conditions on this road: (1) long, steep grades and numerous sharp curves; (2) many long tunnels; (3) high speeds; (4) heavy engines; (5) heavy traffic.

As we prophesied in our last issue would occur, the New York legislature adjourned without passing either the Pavey resolution so to amend the constitution as to permit transfer of the state canals to the Federal Government, or the bill to issue $7,000,000 of bonds to complete the deepening to 9 ft. of the Erie canal. As the case now stands, therefore, the state cannot legally vote to issue bonds for work on its canals before November, 1900, and the canal will be left for at least three seasons in its present condition. It is true that the legislature can vote a direct tax to raise money for canal improvement, but it is very doubtful whether either party would be willing to take the responsibility for such a measure. As for any transfer of the canals to the Federal Government, a constitutional enactment permitting it cannot now be made before the close of the year 1901.

We make the above statement of course on the supposition that the present legislature has completed its work. It has been suggested, and is of course a possibility, that when the canal investigating commission which is now at work has presented its report, an extra session of the legislature may be called for the especial purpose of acting on the proposition to raise funds to complete the canal work. Whether the party in power will be willing to take the responsibilities for so radical an action remains to be seen.

It is quite likely that before the time comes when New York will again consider the question of expending money on canal improvements, the aspect of the question may have been materially changed by the undertaking by the Federal Government or the Canadian Government of the improvement of other waterways from the Lakes to the Atlantic, and perhaps by other new conditions.

It is well known that one of the largest items in the cost of garbage and refuse collection and disposal is that of haulage. It is seldom that the point of disposal is near the center of population and the tendency is to increase rather than to decrease the length of haul. A rather expensive water-tight, covered dumping wagon is required for moving the garbage, and it is generally more economical, with long hauls, to use two horses. Add to the cost of the wagon, the cost of horses and harness, the expense of shoeing and feeding the horses, and the wages of the driver, and it becomes evident why garbage disposal is so expensive when only two or three trips a day can be made by each team employed. In some cases garbage disposal plants are so remote as to make ordinary cartage impracticable, and it is shipped to the disposal works by boat or rail. This always means rehandling either by shovelling twice or by having wagon bodies detachable from the running gear. Trolley lines have been suggested, and perhaps tried, for shipping garbage considerable distances. Aside from the question of rehandling, the use of trolley lines for this purpose might be strongly objected to unless the work is done at night, which is not always convenient, or economical.

In one or more English towns motor dust vans, as they are called, are employed by the street cleaning department. The Vestry of Chelsea, England, recently instructed its engineer, Mr. T. W. E. Higgins, Assoc. M. Inst. C. E., to report on the advisability of buying 15 of these dust vans. The greater part of Mr. Higgins' report, as published in the London "Contract Journal," is reprinted elsewhere in this issue. In general, it may be said here that Mr. Higgins is favorably inclined towards the buying of motor wagons, believing that the cost of service will certainly not be increased thereby, and that the sanitary gain and the reduction in the wear of pavements due to replacing so many horses will be highly advantageous. He rightly urges that those responsible for the condition of streets should encourage the banishment of horses from them.

The idea of using motor wagons for removing garbage, ashes and street sweeping from our streets is worth considering in this country. Aside from the sanitary benefits and the reduction in wear of pavements which their use would involve there should be mentioned the benefit of the wide, well loaded tires where macadamized and dirt roads are used, and the possible reduction in the cost of haulage. Some of the serious questions to be considered are the limitations imposed by heavy grades, snowy or slushy streets, and the bad country roads sometimes stretching between towns and disposal works.

It is significant that all the bids received were for steam driven motor wagons. The makers of electric wagons, Mr. Higgins states, seem to be devoting themselves wholly to light vehicles, chiefly for pleasure riding. As we pointed out some time ago, there seems to be a future for motor wagons for express and freight delivery service, and if this should prove true there is no reason why this class of vehicles should not be used for hauling garbage and other refuse. In many cities the question of grades would not enter into the problem, and in many others snow would not give the slightest trouble. Bad country roads are all too common, but the worst of them are fast disappearing in the vicinity of cities, and a good road to a garbage disposal or similar plant would soon pay for itself. Motor garbage and refuse wagons are worth investigating.

In our last issue we spoke of the good work done by the Metropolitan Park Commission of Massachusetts. Since then we have received, as noted in another column, a report which describes similar good work now being done for Newark, the Oranges, Montclair, and other New Jersey towns by the Essex County Park Commission. This commission was organized about two years ago. It found the county, which includes the cities of Newark and Orange, and a number of other rapidly growing suburbs of New York, almost absolutely without parks. Certain sections of the county were admirably suited for park reservations, and two such tracts of land, one of 1,600 and one of 400 acres, have already been secured in the southwestern and western extremities, respectively, of the county. These are rare stretches of rocky and wooded hills, fields and valleys, with both still and running water. From their highest points practically the whole of Essex County can be seen, besides large sections of other portions of New Jersey, Greater New York, rivers, bays, and the broad Atlantic. It is said that from Eagle Rock, just back of Montclair, can be seen the homes and working places of a greater number of people than can be seen from any other point in the world. Turn about and the eye ranges for miles over hills and valleys, with only here and there a dwelling. A few steps westward and one may reach almost unbroken solitude in the woods. The contrast is wonderful. In the southeastern corner of the county some 200 acres of land, including a small pond, has been secured. Little work will be done on these reservations except to preserve and protect their natural features and provide a few roads and paths.

In contrast with these three rustic parks will be some 250 acres near the most densely populated sections of the district, much of which will be developed by landscape gardening. A portion of this park, together and with three other comparatively small parks, will be designed to meet the needs of those who cannot easily or often go to the distant reservations. Neighborhood parks and children's playgrounds will be the characteristics of these smaller areas.

Parkways are proposed to connect the various parks. These would extend through some of the more rural sections of the county, which scarcely need parks yet, but which will be directly benefited by the parkways. One of the proposed parkways will pass along the very crest of the first range of mountains.

The almost absolute neglect of Newark to secure parks within its limits while land was available and cheap is being dearly paid for now in the high prices of land and buildings. This experience should be a lesson to other communities.

On April 12 the people of Essex County will vote on issuing $1,500,000 of additional park bonds, making $4,000,000 in all, to carry on the

work of the board. Judging from the work of other boards, and making allowances for local conditions, the Essex County Park Commission has executed its trust ably thus far. If the park system can be completed as planned, it will be a most admirable one. Parkways especially are needed now to bind the parks together, and for these we understand a part of the new appropriation will be used.

THE REPORT OF THE MASSACHUSETTS SPECIAL COMMISSION ON STREET RAILWAYS.

A noteworthy report on "The Relations Between Cities and Towns and Street Railway Companies," briefly reviewed elsewhere in this issue, was submitted to the Massachusetts legislature a few weeks ago. The report was made by a special committee of three, consisting of Messrs. Chas. Francis Adams, of Lincoln, Wm. W. Crapo, of New Bedford, and Elihu B. Hayes, of Lynn, appointed by the governor in accordance with an act of the legislature of 1897. The conclusions of the report, so far as they relate to necessary legislation, were embodied in two proposed statutes, the chief provisions of which are given and commented on below.

The most striking feature of the proposed legislation is the authorization of public ownership of street railway tracks, which may be effected by purchase in the case of existing roads, or by construction where new roads or extensions are to be built.

In justification of this provision the committee states that a street railway is analogous to an omnibus line, rather than a steam railway, and the track is but a form of street pavement which, like the rest of the pavement, should be controlled by the municipality. Wherever street railway tracks become the property of a city or town the company would make an annual payment for the use and maintenance of the tracks, the payment to be fixed by mutual agreement for seven-year periods, or by arbitration when an agreement could not be reached. Where municipal ownership of the tracks does not prevail, all present and future obligations of street railway companies in the way of removing snow or paving streets would be changed to money payments ranging from 2 per cent. per annum of the gross receipts where the latter are $7,000 per annum or less to 3 per cent. on $28,000 or more, all track to be measured as single and sidings to be included.

We have long maintained that municipalities should assume the full responsibility and maintain complete control of their street pavements. About a year ago we pointed out the unsatisfactory results which follow when any part of this work is turned over to street railway companies, both from the standpoint of good pavements and compensation for the use of the streets.* There is much to be said in favor of the plan of municipal ownership of the tracks. Such ownership, the Massachusetts commission states, is common in Germany, and it believes it is far preferable to the plan now gaining in favor in England of complete municipal ownership and operation. As we understand it, the commission urges this plan because it believes in public ownership of street pavements, and not because it is convinced that street railways should be so owned. The distinction is important. It removes all reason for surprise that a commission of men commonly held to be conservative should advance so-called socialistic views. The plan may be radical, or novel, from an American standpoint, but there is nothing socialistic in it. The companies must pay a rental for the use of the municipal tracks. The motive involved is wholly one of protection and control of public streets, and is in no way related to a desire to furnish municipal aid or encouragement to cheap transportation facilities. Besides protecting pavements, municipal ownership of the track would give cities control of the bonding of the rails and in general of means for returning current to the power house, thus enabling cities to guard as effectually as they might wish against the electrolysis of water and gas mains, a matter which many cities are not finding it easy to regulate under private ownership of street railway tracks.

The proposed act authorizes municipal purchase of "track, poles and fixtures" of existing railways, but gives power for municipal construction of track only. This limitation may have been an oversight. If public ownership of track is desirable, it is logical that all the street furniture, whether on, above or below the surface, should be owned by the municipality. This is especially true of underground conduits, now becoming more and more common for feeder wires, and which may be used extensively for the whole line system in the future. The construction and maintenance of all underground conduits, regardless of their purpose, have a close relation to pavements and should always be strictly controlled, if not absolutely owned, by the municipality. Whether or not the wires themselves should be owned by the city is more of an open question.

The ownership and maintenance of wires brings up a train of objections likely to be urged by street railway companies against any part of the plan just outlined. One of the principal objections will be that the municipalities cannot be relied upon for proper construction and maintenance of track or wires, thus entailing trouble and extra operating expenses on the companies. This is more likely to be true of overhead than of surface and udergground construction, but there need be no trouble with overhead work on this score, and if there were the overhead construction could remain under private ownership with less objection than the underground work.

Long years of experience have shown the difficulties of compelling street railway companies to live up to their agreements regarding repairs to street pavements. Under present methods of traction the interest of the municipalities in good pavements far exceeds that of the railway companies, and as the track is a part of the pavement and its condition virtually affects some of the remainder of the pavement there is stronger reason for common ownership and repair of the track and the pavement between and just outside it by the city or town than by the street railway company. It is unfortunately true that our public highways, in town and country, are too frequently kept in poor repair; and from this it might be argued that if the responsibilities for the track maintenance were laid upon the municipality, the track would frequently be left in poor condition to the detriment of the street railway's rolling stock and the discomfort of travelers.

On the other hand, it is to be said that one reason why street pavements are left in poor repair is that no one has a sufficient interest in their condition to keep the public officials up to their work. In the case of street railway tracks, however, the company would be sure to protest if city officers seriously neglected the tracks and their demands would be enforced by the public generally, which rides in the cars.

Another objection likely to be strongly urged by the companies is that they could construct and repair the tracks more cheaply than the municipalities, and that they should be allowed to effect any possible saving in this way. The proposed law provides that in case of disagreement as to the rate of compensation for the use of muicipal tracks, it shall be determined by three persons appointed by the State Supreme Court, the basis of the award to be "interest on the actual cost of the tracks in question, together with a reasonable allowance for the repair and renewal of the same." This seems a reasonable safeguard against excessive rentals, since the first cost is liable to review by disinterested parties, and presumably by the courts, and municipalities can obtain money at lower rates of interest than private companies.

Taken all in all, we believe that this proposition for municipal ownership of street railway tracks is based on sound principles of public policy, and that such disadvantages to the companies as might result in practice would be overbalanced by the consequent reduction of friction with city governments.

Doubtless there are many communities where the plan would be inadvisable to-day, owing to a variety of local circumstances, but the proposed legislation is permissive, not compulsory, in character, so far as municipalities are concerned. Where companies object to the plan they are not compelled to accept it in the case of new construction, although this is only a negative satisfaction. Existing roads could not directly resist municipal ownership of track, but if they objected seriously they might be able to effect some satisfactory compromise under which an increase of municipal control would be accepted in place of ownership of the tracks.

Of the wisdom of substituting cash payments for work which the company is obliged to perform, such as removing snow and repairing pavements, we have no doubt. Whatever may be said against ownership of tracks by cities, unquestionably the pavements should be so owned and controlled. There may be cases where in granting new franchises a city can secure a certain amount of street paving and nothing else in return for the use of the streets, but this is generally a delusion so far as real compensation to the city is concerned.

We come next to the second proposition of the Special Commission, which relates to the questions of compensation for franchise privileges and public regulation of rates of fare. The payments discussed above are distinctly declared to be for physical benefits received, and not for franchise rights. Further provisions in the proposed legislation look to some share by the municipality in the profits of street railways, when those profits exceed a certain rate.

Under existing laws the street railway and other corporations pay the state a franchise tax which is distributed pro rata to the cities and towns in which the stock of the companies is held. The proposed legislation provides for the distribution of this tax among the several municipalities on the basis of their track mileage. This does not affect the amount of the tax, but simply its distribution. In order that fares may be kept down or profits divided with the communities in which street railways are operated, it is proposed that there shall be added to the franchise tax a sum equal to all dividends declared in excess of 8 per cent., provided that this payment shall not be required of companies whose aggregate dividends from date of organization shall not equal 6 per cent. per annum. We agree with the commission that this plan is better than limiting the dividends to any specific rate, since that tends to lessen the motive to operate the road as advantageously as possible after the stipulated dividend has been reached. It is questionable whether the city will receive all it ought in the way of compensation under this plan. It will get no compensation unless a dividend of more than 8 per cent. is declared, which some would think unfair, and outside of Massachusetts, at least, ways of dividing profit could be found by means of which the dividends could be kept down to 8 per cent., so the city would get nothing. But as the proposed legislation provides for cash contributions for street work based on the gross receipts of companies, as outlined above, and as provision is made for the regulation of fares, the public is really pretty fairly looked out for under this plan.

As to the reduction of fares, it is provided that governing bodies of municipalities may apply to the State Railroad Commissioners for such reductions,

> but such fares shall not, without the consent of the company, be reduced below the average rate of fare charged for similar service by other street railway companies, which, in the judgment of the Board of Railroad Commissioners, are operated under substantially similar conditions.

This provision is to be a substitute for one in the present law authorizing reduction of fares, but prohibiting them against the wishes of the company when the fares proposed would give a company

> with all other profits derived from operating its road, an income of less than 10 per cent. upon the actual cost of construction.

The commission says that the latter provision tends to defeat itself, since the very reason why 10 per cent. dividends are not earned, in some cases, may be that the fares are too high. While we agree fully with this we must take exception to the proposal to base fares in one city on the average of those in others, even if "similar service" and "similar conditions" are to be taken into consideration. As has been repeatedly urged in

*See Engineering News, June 17, 1897: "Street Paving an Improper Basis of Compensation for Street Railway Franchises."

these columns, cost of service and reasonable returns on capital form the only proper basis for determining the rates to be charged by franchise companies. A strict interpretation of "similar service" and "conditions" would probably result in narrowing down to a few street railways the fares to be used in making up an average. Besides this, five cent street railway fares are so nearly universal that the provision does not seem calculated to be of much force in any event, further than might be secured by providing for five cent fares at the outset. On this point we may possibly be mistaken, the prevalent Massachusetts fares being possibly more variable than in other states.

Some other changes in legislation proposed by the commission may be recited briefly. In order to give property owners a hearing in the granting of franchises for railways to pass in front of their property without enabling them to block a proposed railway line by the mere refusal of a majority of consents, as is possible in some localities, it is proposed that the majority in value, or not less than ten in number, of owners of real estate abutting on the line of a proposed street railway for which consent of the local governing body has been given, may appeal to the State Railroad Commissioners and the road cannot be built until its location is approved by that board. The same rule applies to extensions of existing lines.

The revocation of grants for the location of tracks, assumed by municipalities for years past, would be definitely established by the proposed legislation, provided such action be approved by the State Railroad Commission. This seems to be a point gained by the street railway companies, since it appears that now their only recourse in the case of the revocation of a franchise is an appeal to the courts.

A proposition directly in the interest of all concerned is a provision for assessing upon the street railway companies the cost of any street widening made necessary by street railways, either at or after the time of construction. This provision makes definite and assured the right of municipalities to assess street railway companies for street widening and by a further provision the companies are allowed to make a corresponding increase in their capital stock, a thing which could not be done under existing legislation.

However this report may be accepted in Massachusetts or elsewhere, it is certain that radical changes must be made both there and in other states in the relations between municipalities and street railway companies. All of the recommendations of the commission are worthy of serious consideration by those interested in the subject, and most of them we believe are founded on sound principles of policy, and are in the interest of both the taxpayers and the street railway stockholders, as well as the traveling public. It must be remembered that the report is designed to meet conditions existing in Massachusetts, some of which are peculiar to that state. But most of the recommendations made relate to problems common to the whole country and offer solutions which are worthy at least a trial in many other states.

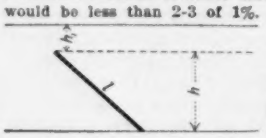
LETTERS TO THE EDITOR.

Bending Moment in Beam Subjected to Water Pressure.

Sir: In your issue of March 17, 1898, Mr. James W. Rickey gives a formula for determining the maximum bending moment in an inclined beam, resisting water pressure, the top of the beam being below the surface of the water.

In this connection it may not be out of place to recall the investigations of M. l'Inspecteur Générale Chevallier, published in the "Annales des Ponts et Chaussées" in 1850. He there demonstrates that the maximum bending moment at the point most strained, in a beam resisting water pressure, the surface of the water being on a level with the top of the beam, exceeds the bending moment at the center of the beam, considering it to be supported at both ends and subjected to a uniformly distributed load over its length equal to the total actual pressure on the beam, by but 1-39 part.

If the surface of the water rises above the top of the beam the difference between these bending moments becomes less as the depth of the water over the top increases. Let us take a numerical example; suppose a weir to be inclined at an angle of 45°, the length of the shutter to be 20 ft., and the depth of water flowing over the crest to be 10 ft.—conditions too extreme, probably, ever to be found in practice. The difference between the bending moment at the section most strained and the maximum moment obtained under the second hypothesis would be less than 2-3 of 1%.



In consideration of the fact that in practice, on account of the imperfections in the materials we must use, we are obliged to make the sections of our beams from 300% to 1,000% greater than the actual strains would theoretically require, it would seem that great refinements in such calculations are unnecessary.

The writer does not intend these remarks as a criticism on Mr. Rickey's work. Without the knowledge of the exact methods of calculation it would be impossible to determine the limits of error for an approximate solution.

Reducing the above proposition to algebraic form and slightly changing the nomenclature for convenience, we have.

$$M_{approx} = 3.9\, l^2\, (h + 2\, h_1) \qquad (1)$$

If in this h_1 is made equal to 0, the formula reduces to

$$M_{approx} = 3.9\, l^2\, h \qquad (2)$$

Adding to this the correction spoken of above, viz.: 1-39, the formula becomes

$$M_{max} = 4\, l^2\, h \qquad (3)$$

Which will give correct values.

If the weir is vertical, l becomes equal to h, and formula (3) reduces to

$$M_{max} = 4\, h^3 \qquad (4)$$

the same as given by Mr. Rickey. Formula (1) will give true values within about 2½%, the value approaching more nearly the actual maximum as the depth of the water over the weir increases.

Very truly yours, James H. Fuertes.

New York, N. Y., March 17, 1898.

The Computation of Strains in Coal and Grain Bins.

Sir: In your issue of March 3, 1898, Mr. Cain asserts that it is necessary to take into account the wall friction in the computation of strains in coal bins. This assertion is erroneous, as I shall prove later on; confuses the question, and may give the impression that thus far the discussion had failed to give positive and reliable results. As several of your readers have expressed the interest with which they follow the question, it seems desirable to me to summarize as briefly as possible what I think has been proved by the discussion, viz.:

(a) The methods indicated in Engineering News, Nov. 4, 1897, by Mr. Sadler, Professor Howe, Professor Church and my formulæ, and sustained by your comment on Mr. Sadler's letter do not differ essentially and will give reliable values for the strains. The only difference is that Mr. Sadler and Profesor Church indicate merely the method for the special case without working it out; that Professor Howe gives a graphical solution, and that my solution of the problem is analytical.

(b) The jar, etc., to which a bin is subjected has only influence upon the value of φ, the angle of friction; but not upon the correctness and applicability of the formulæ. φ once determined in a given case, should be kept the same throughout the entire computation. In cases where it would be advisable to take $\varphi = 0$, my formulæ will give the hydrostatical laws.

(c) In determining the section of horizontal ties, special attention should be given to the unfavorable conditions in which they are in regard to rust, surface damage, the additional strain resulting from overlying coal, etc. In ordinary cases approaching the design of the coal bin at Paterson, 8 should be considered a proper minimum factor of safety for these pieces.

(d) The method of Mr. Barton (Eng. News, Dec. 30, 1897) differs only from the methods mentioned under (a) in his mistake to take the projection of M A, instead of M A (Fig. 2). This apprehension that the parallelogram of forces might not hold good for a granular mass is unfounded. A study of the theory will show that Rankine's ellipse itself is based upon nothing else than the parallelogram of forces; and that it is only necessary to have a clear idea of the difference between pressures and intensities of pressures.

(e) The computation of strains in grain elevators is an entirely different problem. No theory exists on the subject and the experiments of Mr. Roberts (Eng. News, Jan. 27, 1898, cannot give any reliable base for construction.

(f) The analytical solution of Professor Howe (Eng. News, Jan. 27, 1898) gives the same results as the methods mentioned under (a), except that Professor Howe now gives a formula for the pressure upon the inclined side, while the normal pressure, as given in his graphical solution (Eng. News, Nov. 4, 1897), is all that is practically needed in the case under consideration.

(g) The assertion of Mr. Cain that it would be necessary to include the wall friction in the problem (Eng. News, Mar. 3, 1898), is erroneous. This may be desirable in some cases of retaining walls, but certainly not in the computation of coal bins. In the latter case it is not the question of the overturning of a wall with a certain width at the base, but of a computation of strains in a frame work.

The foregoing conclusions will give a reliable, practical and safe guide for the designing and construction of coal bins. J. J. Israëls, C. E.

Denver, Colo., March 8, 1898.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Assessment for Water Connections.

An assessment by a city on particular property-owners, made to cover the expense of water connections, between their properties and the water main, put in by order of the common council, without authority or request of owners, is illegal, unless there is a provision for such taxation in the city charter. London v. Syracuse, 46 N. Y. Supp. Rep., 1053.

City Cannot Sign Frontage Petition.

Under a statute authorizing paving to be done in a city when the person owning real estate which has at least one-third of the frontage of the street, or portion of the street, the improvement of which shall be desired, shall in writing request the commissioners of streets and sewers to make such improvements, the city cannot, as an owner of property fronting on such street, join in signing such request, in order to make same come up to the legal requirement as stated. Atlanta v. Smith (Sup. Ct. Ga.), 27 S. E. Rep., 990.

Bidders Must Have Notice.

A county board, having awarded a contract for public work to the lowest bidder, cannot legally determine that he has failed to sign the contract, and to furnish the required bond within a reasonable time, and then award the contract to another, without giving the first bidder an opportunity to be heard. Stanley v. Board Passaic County (Sup. Ct. N. J.), 38 Atlantic Rep., 181.

Water Pipes Taxable in Maine.

The aqueducts, pipes and conduits of water companies are subject to municipal taxation as real estate unless the town takes water from same for the extinguishment of fires without charge. Dover v. Maine Water-Works Co. (Sup. Ct. Me.), 38 Atlantic Rep., 101.

THE ECONOMETER; FOR DETERMINING CARBONIC ACID GAS IN CHIMNEY GASES.

The "Econometer" is the trade name of an instrument invented by Mr. Max Arndt, of Aix-la-Chapelle, Germany, for the continuous indication of the specific gravity of gases, and especially for indicating the percentage of carbonic acid gas in the escaping chimney gases of steam boilers or other furnaces. It has recently been introduced in this country by Mr. Joseph Wilckes, 106 Fulton St., New York, and its merits have been favorably reported on by a committee of the Franklin Institute, which has awarded to the inventor the Elliott Cresson Medal. The accompanying cut is an illustration of the instrument, and we condense the following description of it from the Franklin Institute Committee's report:

This apparatus consists of a balance carrying at one end a gas vessel provided with a neck open at the bottom; a gas delivery pipe projecting upward into this gas vessel being fixed and supported in it in such a way that upon the oscillation of the balance beam the gas vessel may move freely up and down, not coming in contact with the upward projecting pipe through which the gas flows into the gas vessel.

The gas vessel is balanced by a compensating vessel suspended from the opposite end of the beam; also open at the bottom, and equivalent to the gas vessel in its capacity, in conjunction with small weights placed under a pan under the compensating vessel, so that the pointer of the beam shall move to zero on the scale when atmospheric air is drawn through the apparatus.

The gas vessel being open at the bottom so that the pressure within it is always the same as that without, fluctuations of pressure and barometrical readings have not to be considered in the use of this apparatus, likewise fluctuations of temperature do not affect its action because the gases passing slowly through the apparatus quickly take the temperature prevailing in the narrow gas passages.

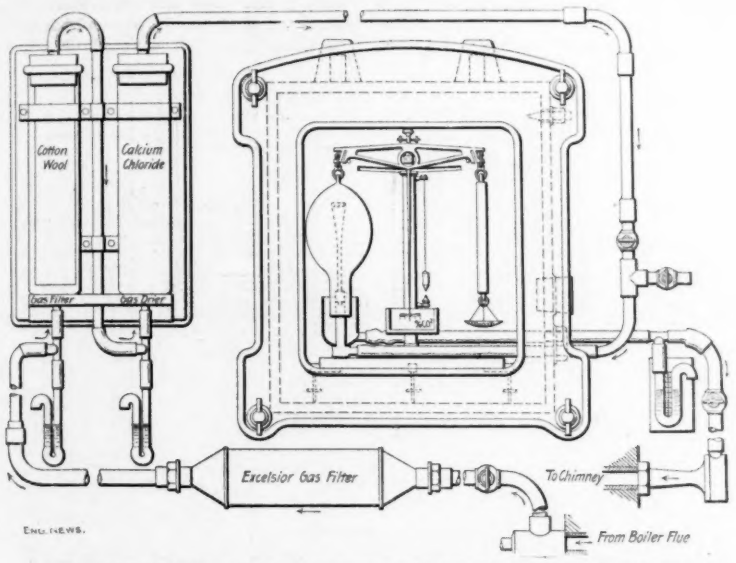
The fluctuations which take place in the density of the gases around the fixed pipe in the gas vessel cause up and down motions in the latter vessel which are shown by the pointer on the scale. The divisions of the scale indicate either units of weight or the percentage volume of a particular kind of gas, such as carbonic acid, in a gaseous mixture.

The source of the gas supply is placed in communication with the inlet to the gas vessel and a suction apparatus of any suitable kind in communication with the outlet from the cup-vessel under the gas vessel. A portion of the air present in the casing is first drawn off, that is to say, the air is exhausted by the suction to so much of a vacuum as corresponds to the strength of the suction at the cup vessel under the gas vessel. This rarefaction being obtained, the gas to be weighed passes into the gas vessel, filling it, and then out of this vessel into the cup vessel below.

The gas balance is enclosed in a casing provided with a glass front for the purpose of observation; this casing is provided with an aperture closable by a plug, upon the removal of which the weights may be adjusted as required. At the top of the casing there is an aperture filled with cotton wool for the gradual and continuous admission of atmospherical air thereto. The balance is, therefore, located in a nearly air-tight chamber with its several parts so arranged that, when the gases to be weighed flow through a vessel forming part of the balance, it may operate without resistance and with greatest sensitiveness.

The determination of the percentage volume of a gas in a gaseous mixture is only practicable by means of the apparatus when the specific gravity of the gas sought for is different from the specific gravities of the other gases. This, for instance, is the case with respect to the smoke gases of a steam generator furnace, which gases are mainly made up of oxygen, nitrogen, carbonic oxide and carbonic acid. Of these, the first three are of nearly the same specific gravity, approximating that of atmospheric air, = 1. On the other hand, the specific gravity of carbonic acid = 1.52, and a smoke gas mixture must consequently be heavier the greater its contents of carbonic acid. With perfect combustion of the carbon contained in the fuel, and with the air of combustion measured in a theoretically accurate manner, the carbonic acid of the smoke gases amounts to about 20% of the total volume, but it is less than this when the air of

combustion is supplied in a larger quantity. If the zero line of the scale has such a position that it coincides with the pointer when only atmospheric air is present in the gas vessel; if the end line or division of the scale has such a position that it coincides with the pointer when atmospheric air mixed with carbonic acid to the extent of 20% of the total volume as determined by a chemical analysis, is drawn through the gas vessel; and if the scale has 20 corresponding divisions; then the movement of the pointer from one division to another will correspond to the difference in the weight of the gaseous mixture in proportion to the percentage volume of carbonic acid. Accordingly, in the practical use of the apparatus, that is to say, when smoke gases are being conducted through the gas balance, the contents of carbonic acid as indicated by the pointer in a sufficiently accurate manner for practical purpose, may at any time be read off from the scale direct. The gas balance herein described is of great importance as a controlling apparatus for steam



THE "ECONOMETER," AN INSTRUMENT FOR INDICATING THE PERCENTAGE OF CARBON DIOXIDE IN FLUE GASES.

Joseph Wilkes, 106 Fulton St., New York, Agent.

generator and other furnaces, and also for obtaining the specific gravity of other gaseous mixtures by direct weighing.

In the operation of a steam boiler the higher the percentage of carbonic acid gas in the flue gases the less is the excess of heated air uselessly escaping into the chimney, and the greater, consequently, is the economy of the boiler. From a table given in the circular describing the Econometer we extract the following figures, showing the relative loss of heat in the chimney gases due to different percentage of CO_2:

Per cent CO_2	2	3	4	6	8	10	12	15
Quantity air, times theoretical requirements	9.5	6.3	4.7	3.2	2.4	1.9	1.6	1.3
Loss fuel, gases htd to 270°C.*	90	60	45	30	23	18	15	12

*518° F.

The results of a series of tests of the Econometer made by the Franklin Institute committee on a Babcock & Wilcox boiler, using anthracite coal, at the Baldwin Locomotive Works, are given in detail in the report. Samples of gas were drawn for chemical analysis, and during the times of drawing the samples readings of the Econometer were made every half-minute. The average readings compare as follows with the analysis for CO_2:

Econometer, %	3.80	4.70	3.93	8.53	10.40	6.90	4.40
Analysis, %	4.02	4.84	4.12	9.06	10.53	6.57	4.38

A series of tests made by the Pope Mfg. Co., Hartford, Conn., in Sept., 1897, gave comparative results as follows:

Econometer, %	9.33	10.94	9.63	10.00	6.20
Analysis, %	9.00	10.60	8.80	8.50	6.40

The apparatus has recently been introduced in the following works, and favorable reports of its practical working have been received from them all: Amoskeag Mfg. Co., Manchester, N. H.; S. D. Warren & Co., Cumberland Mills, Me.; Botany Worsted Mills, Passaic, N. J.; Equitable Gas Light Co., New York city, and Leominster Worsted Mills, Leominster, Mass.

EXPERIENCE WITH STEEL TIES ON THE GOTHARD RAILWAY, SWITZERLAND.

The subject of metal ties, and of the respective merits and advantages of metal and wooden ties, has had a large place in European technical literature, and in the discussions of railway and technical societies during the past 20 years, and has been reported upon in detail at the several meetings of the International Railway Congress. The many improvements in shape, material and methods of manufacture of steel ties and their fastenings, and the careful investigation as to manufacture and to maintenance in the track, particularly since 1880, are now showing results in decidedly favorable figures as to maintenance and renewal on railways where steel ties have been extensively and intelligently used. A large number of the important patents covering improvements in steel ties have now expired, and have no longer an influence on the cost of manufacture, so that the various systems can be considered purely on their merits.*

On the Gothard Railway, of Switzerland, metal ties have been in use since 1882, and the various questions incident to their use have been under careful consideration during the 16 years that the road has been in operation. The results of experience have been such as to lead that road to introduce these ties very extensively, although as Switzerland has no steel industry, there was no incentive to do this merely to encourage manufacture. As this road has steep and long grades, numerous sharp curves, long and winding tunnels, and a very heavy traffic, the particulars of its experience in this direction have an important bearing on the steel tie question. The following particulars as to this experience are taken from a report showing the results obtained up to January, 1898, and stating the present opinions of the officers of the railway, which information is of special value.

At the opening of traffic in June, 1882, wooden ties were used exclusively, these being of oak, pine and larch. At the end of 1882 the old form of Mr. J. W. Post's iron tie was laid on a trial section of track 2.3 kilometres (1.4 miles), in length, on the Bellinzona-Giubiasco line. Since 1886, the railway has used the improved forms of the Post steel tie, both for extensions (double tracking) and for renewals. On Jan. 1, 1898, this road had 70% of metal ties in its main track, and the ties on the entire road were classified as shown in Table No. 1:

TABLE No. 1.—Steel Ties on the Gothard Railway; Jan. 1, 1898.

	Ties. Iron and steel. No.		Wooden. No.		Total. No.
Main track	395,000	70%	169,000	30%	564,000
Sidings	45,000	39%	71,000	61%	116,000
Total	440,000	65%	240,000	35%	680,000

The increase in weight and dimensions from 1885 to 1898 are shown in Table No. 2:

TABLE No. 2.—Dimensions of Steel Ties on the Gothard Ry., 1885 to 1898.

	1885-'87.	1887-'92.	1892-'95.	1895-'98.
Weight, lbs	120	128 & 132	146	163
Weight, kilos.	54.5	58 " 60	66	74
Length, ft.	7⅞	7⅞ " 8⅛	8⅛	8⅜
Length, meters	2.4	2.4 " 2.5	2.5	2.7
Thickness of top, in.	11-32	5-16 & 15-32	15-32	15-32
" " " mm.	9	8 & 12	12	12

A comparison of the present prices of oak ties 8 ft. 10 ins. long and mild steel ties weighing 163 lbs., is given below, and when the expense of laying is added and the value of old material deducted, this shows a result of about 3½% in favor of the steel tie. The fastenings used with the oak tie include two tie-plates and six spikes

	Ties. Steel.	Oak
Cost of tie	$1.72	$1.20
Cost of set of fastenings	.24	.41
Total	$1.96	$1.61
Total, including expense of laying and deducting value of old material	$1.60	$1.66

The St. Gothard Railway has only 57% of its length on tangent, 43% consisting of curves, while 19% consists of curves of 914 ft. and 984 ft. radius (6.3° to 5.8°). The maximum grades on the mountain lines are 2.7%.

The heavy express engines weigh 100 tons, with a maximum axle load of 15½ tons, and these engines have maximum speeds of 39 miles per hour on the mountain line and 53 miles per hour on the valley line, these speeds being maintained on curves.

For the first year or two, the expenses for ordinary maintenance (tamping, surfacing, etc.) are about the same for track with steel ties and track with wooden ties. After that period, however, these expenses become decidedly lower for the track with steel ties. The lateral displacement of the track on curves is less with steel ties, as the ends of these have a firmer hold in the ballast.*

The steel of the ties ordered during 1885-1887 had a tensile breaking strength of 30 to 33 tons per sq. in., and many of these ties had to be removed on account of cracks occuring in the corners of the punched bolt holes. These cracks have also developed, but to a less extent, in the ties of 1887-1892. The ties ordered since 1892, however, have a maximum tensile strength of 30 tons per sq. in., and these have shown no cracks. In this connection it may be noted that since 1889 the Netherlands State Railway (of Holland) has used Post's steel ties with drilled instead of punched holes, and though these are lighter than those of the Gothard Railway they have shown no signs of cracks.

In the long tunnels of the Gothard Railway, the steel ties are subject to rust, and last only 8 to 10 years, which is about the life of the oak ties. Outside the tunnels, however, the influence of rust, and the wear under the rails and at the bolt holes is so slight that the steel ties are expected to last as long as the rails, which of course is very much longer than the oak ties. New wooden ties are now, therefore, used only on tangents in long tunnels, and for temporary renewals on the Cenere line, until the light rails on this line are replaced with heavier rails on steel ties. The general result in point of durability, therefore, is that the steel ties on this railway, even with its many and long tunnels, have proved to be more economical than oak ties.

In regard to the question of rust, it is interesting to note the experience with the 1,000 iron ties of the Cosyns type, laid in 1865 on the Deventer-Oist line of the Netherlands State Railway (Plate LXVII., Trans. Am. Soc. C. E., June, 1888). This type is now considered a poor one, but the ties

*Information as to the extent and character of metal ties in use throughout the world, with details of the fastenings used, etc., will be found in considerable detail in three reports made to the Forestry Division of the U. S. Department of Agriculture by Mr. E. E. Russell Tratman, Assoc. M. Am. Soc. C. E., Associate Editor of Engineering News, namely, Bulletin No. 3, 1889; Bulletin No. 4, 1890, and Bulletin No. 9, 1894. Figures of the records of cost of maintenance, etc., will be found in these reports and also in a paper on "Maintenance, Expenses of Track on Metal Ties," by Mr. J. W. Post, of the Netherlands State Railways, in the Transactions of the American Society of Civil Engineers, June, 1888.

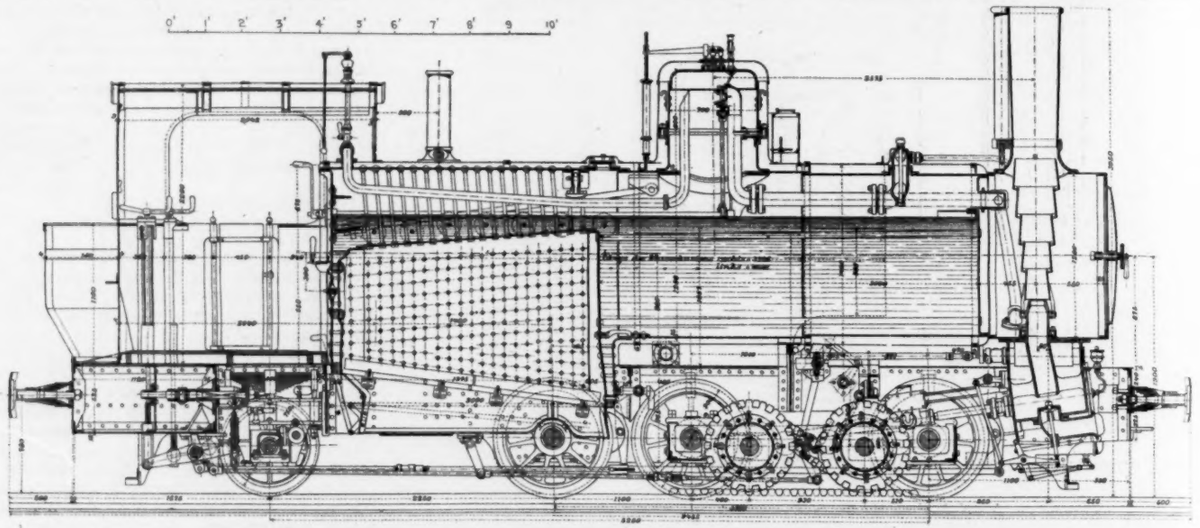
*See Plate LXVII., Transactions of the American Society of Civil Engineers, June, 1888.

have been in the track for 33 years, and the oak blocks on which the rails rest are now being replaced with cast iron blocks, the rusting of the ties being so insignificant that the ties are expected to last for many years yet.

As to the safety of the track, the report states that even if the steel ties were less economical than the wooden ties, the Gothard Railway would still feel obliged to use the former on account of the greater security and safety of the track. Wooden ties, indeed, would only resist for a few years the wear due to the fast and heavy traffic on so winding a line.

THE BEIRUT, DAMASCUS & EL MUZERIB RY., OF SYRIA, AND ITS LOCOMOTIVES.

We reproduce herewith from our contemporary, the "Zeitschrift des Vereines Deutscher Ingenieure," drawings of a rack locomotive, which will be a curiosity, we believe, to most American locomotive designers. The detail which is most calculated to arrest the attention of the reader is the petticoat pipe in the smoke-box; and the multiplicity of petticoats which it boasts is something which we venture to believe cannot be equalled in America, at least in locomotive construction. We will refer later on to some further peculiar details in the design of this machine, but it may first be of interest to give our readers a brief account of the railway on which it runs.



LONGITUDINAL SECTION OF ABT RACK RAIL LOCOMOTIVE FOR THE BEIRUT & DAMASCUS RY., SYRIA.
Designed and Built by the Swiss Locomotive & Machine Works, Winterthur, Switzerland.

As long ago as 1858 a company was organized in Paris for the carriage of freight and passengers between the famous Oriental cities of Beirut and Damascus, and soon afterwards it undertook the construction of a turnpike road between these cities, which it finished four years later. The distance was 70 miles, and the road had to cross a mountain range on the way which made necessary an ascent of about 5,000 ft. Over this road for many years the company ran passenger coaches and road wagons, and the traffic, which amounted to some 15,000 passengers, and 35,000 tons of freight per annum at the start, grew to large proportions. The population of Beirut is about 112,000, and of Damascus about 200,000. The profits of the company eventually attracted competition. In May, 1891, a Mussulman named Hassan Effendi Beihoum, obtained a firman at Constantinople authorizing the construction of a steam railway line between the cities. At about the same time a Belgian syndicate obtained a concession for a railway from Damascus south toward El Muzerib. In December, of the same year, the three interests above named were consolidated, and construction work was undertaken. The line from Damascus south toward El Muzerib was completed and opened to traffic on July 4, 1894, a date which makes one think some Americans must have had a finger in the pie. The construction work on the line from Beirut to Damascus was more difficult, and it was not finally completed and opened till Aug. 3, 1895.

It may be mentioned here that the name of the consolidated company is the "Compagnie Ottomane des Chemins de Fer économiques en Syria," with offices at 21 Rue de Londres, Paris, and at Beirut. M. Ch. Roederer is the Consulting Engineer in Paris, with MM. P. Blanche and L. Balland as engineers-in-charge. E. Hanin is the Chief Engineer in Syria, with offices at Beirut. The company has franchises for an extension north from Damascus via Homs, Haina and Oleppo to Biredscheik, on the upper Euphrates river, which will give the company a total of 348 miles when completed.

Mention has already been made of the mountain range which the Beirut-Damascus line had to cross. In the account in the "Deutscher Ingenieure," from which we take our information, it is stated that if the road had been built with the usual grades for adhesion locomotives, its cost would have been almost prohibitory. Whether an American locating engineer would have found this to be the case or not we cannot say, but at any rate it was decided to lay the Abt rack rail on the steeper portions of the line. The contract for 20 miles of Abt rack rail and for all the locomotives required was let in December, 1892, to the Swiss Locomotive & Machine Works of Winterthur.

The steepest part of the line is the ascent from Beirut to the summit of the Lebanon mountains, on which grades of 7% occur. The divide is crossed at a point 37 km. (23 miles) from Beirut at an elevation of 1,487 m. (4,880 ft.) and next comes a descent with 6% grades to an elevation of 1,105 m. The average grade on the steepest section from the foot of the mountain to the summit, 32 km., is about 4½%. Certainly an American engineer would hunt a long time to find opportunities for developing his line and reducing grades before he would adopt the rack system for such a road.

Concerning the permanent way, we may note that the rails are of a section which very much resembles the Am. Soc. C. E. standard, and they are laid with suspended angle-bar joints, which also closely follow recent American practice. The ties are of steel, of the Vautherin pattern, weighing 37.8 kg. (83 lbs.) each. The rack rail is laid on all grades steeper than 2½%, and on all such grades a concrete block is solidly built in the roadbed every 50 to 60 meters, and the next cross tie above it rests against this block.

Returning now to the locomotives, the adhesion locomotives are 6-driver tank engines with a pony truck, outside frames, and one of the complicated valve-motions that European locomotive designers love so well. Most of the curiosities in connection with their design are repeated in the rack locomotives which are illustrated herewith. The rack locomotive has a trailing pony truck which is called by our contemporary an "Adam's" truck. Whether its invention is to be traced to the veteran car builder of the Boston & Albany, or to a gentleman who is reputed to have resided in the region which this railway will penetrate, we are not informed.

The boiler presents many peculiarities which those familiar with American locomotive design will at once notice. The slope of the firebox connected to the rear is, of course, to prevent the crown sheet from becoming bare when the engine is running down hill. The safety-valve is of the lever type, its end held down by a spring. The throttle-valve is a slide-valve, as is still common in Europe.

The locomotive has four cylinders, two of which drive the adhesion-drivers and two the rack gears, and the engineer can let steam into either or both pairs. All the cylinders exhaust into the same exhaust nozzle, over which the ballet-dancer petticoat-pipe, before noted, stands guard. At the base of this exhaust nozzle is a really ingenious device, the purpose of which, as we have studied it out, appears to be about as follows: For braking purposes, when running down hill, either pair or all four of the cylinders can be used as air-compressors, on the well-known Le Chatelier system. But when this is done the air taken into the cylinders is apt to be drawn from the smoke-box, and ashes and grit are carried in and cut the surfaces of valves and cylinders. To avoid this, the engineer, when he reverses his engine, at the same time operates a lever which closes the passage from the cylinders to the smoke-box and opens a passage from the exhaust chamber to the outer air.

The principal dimensions of the locomotives built by the company above named for this railway are as follows:

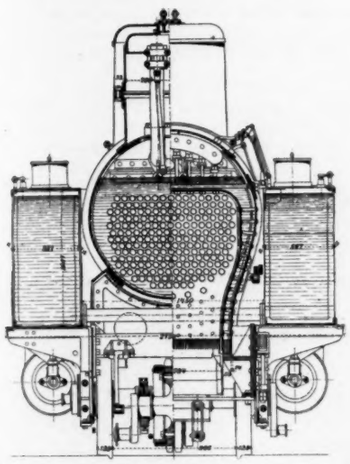
	Locomotive		
	Adhesion.	Rack-rail— Adhesion.	Rack.
Diameter of cylinders, ins.	14.96	14.96	14.96
Stroke of pistons, ins.	21.65	19.68	17.72
Diameter of driving wheels, ins.	41.34	35.43	27.09
Steam pressure, lbs.	175	175	
Grate area, sq. ft.	15	17.5	
Heating surface in fire box, sq.ft.	75.66	98.11	
Heating surface, tubes (inside), sq. ft.	790.08	945.14	
Total heating surface, sq. ft.	845.74	1,031.25	
Rigid wheel base	110¼ ins.	118.11 ins.	
Total wheel base	196.85 "	206.7 "	
Weight, empty, lbs.	67,690	75,190	
Water in boiler, lbs.	6,284	6,923	
Capacity of tank, gallons	1,215	1,321	
Capacity of coal box, lbs.	4,400	5,500	
Weight in working order, lbs.	88,530	98,650	
Adhesive weight, lbs.	66,150	74,970	
Tractive force, lbs.	10,580	10,010	12470

SIR HENRY BESSEMER.*

Sir Henry Bessemer died on Tuesday evening, March 15, at his residence at Denmark Hill. He was born on the 19th of January, 1813, and his long life has carried

*Condensed from an article in "The Engineer" (London), March 18, 1898.

him into a generation for whom his achievements lack the interest which they possessed for the few great metallurgists his contemporaries, yet alive. But the man himself was too remarkable in many respects, and his career too instructive and suggestive, to be passed over wholly in silence. Bessemer was a very peculiar product of the nineteenth century. His total lack of systematic scientific training at once made him and marred him. If Bessemer had been carefully taught metallurgy, as it was understood in the days of such men as Truran, for example, he would never have invented the Bessemer process. On his own showing, indeed, he rather blundered upon it than invented it; and he was carefully assured by those who were supposed to know all about steel making that ever had been known or could be known, that the process was wholly impossible. No scientific training stood in the way and stopped Bessemer from trying experiments. In a single instance he was successful, and his success worked a greater change in the world's ways than it is easy to realize. But it is said that he spent no less than £10,000 on Patent-office fees; and of all the hundreds of inventions which he made, very few attained to success. The reason must be sought in Bessemer's character. His ideas singularly lacked proportion. He failed to catalogue all the conditions affecting an invention, and determining its success or its failure; and to those whose existence he did recognize he was wholly incapable of attaching a just value. For example, he invented a steady cabin for ships, which was to prevent sea sickness. This cabin or saloon was hung upon gimbals, and somewhere about the middle of it was mounted a fly-wheel weighing a couple of tons, which was to revolve at 1,000 or 1,500 revolutions per minute. The gyroscopic action of the revolving mass was to keep the saloon steady. The Bessemer steamship, on which he certainly spent £25,000, and probably twice that sum, was a pronounced failure. Again, he spent very considerable sums on the production of a steam gun. In order that the action of the steam on the bullet might be sufficiently prolonged, the barrel was coiled up in itself in a flat spiral, terminating in a few feet of straight pipe at a tangent to the rest. He took an almost childish delight in seeing this weapon flatten lead bullets against an iron plate; he quite failed to see that there was no use for such a thing, or that it was as absolute a toy as the steam gun of Jacob Perkins. No doubt if Bessemer had had a sound mechanical training he would have avoided this class of work; but, on the other hand, he would have lost that splendid audacity of ignorance which led him to magnificent triumphs.



Cross-Sections of Beirut & Damascus Locomotive.

Until Sir Henry Bessemer's autobiography is published very little will be generally known concerning his early life. His father was a Frenchman, an artist, and a member of the French Academy of Sciences. We believe we are correct when we state that young Bessemer first made a living by designing patterns for Paisley shawls.

Early in his career, long before the advent of the steam gun, he turned his attention to ordnance, and tried to make shot, with spiral feathers and other devices, to do away with rifled grooves in the gun. But he could not get cast iron strong enough to satisfy his needs, and nothing would serve him but he must try to make a tougher metal. His first experiments were made in 1855. He melted pig iron in a reverberatory furnace, and into the molten metal he put broken-up bars of blister steel. Bessemer made a model gun of his new metal and took it over to France. He presented it to Napoleon III., who was much pleased with the weapon. He proceeded to erect gun-casting works at Ruelle, for the French government; but these were stopped by a discovery which he made in London.

The history of the Bessemer process, even in its earlier stages, would fill a volume. The invention as it is known now was not arrived at for years. Up to a certain point Bessemer had things all his own way, and then came a crash. It was found, indeed, that steel could be made, but only with utter uncertainty as to the quality of the product. It was necessary to leave a little carbon in the metal, but the percentage depended on the duration of the blow, and no satisfactory commercial result was possible. But besides this, far from getting rid of sulphur and phosphorus, the process seemed to aggravate the evil of their presence. In a word, the whole process was a failure. He worked away for more than two years, and at last succeeded in producing a salable article from a pure ore, but by this time the steel makers had lost all faith in the affair. Bessemer, however, about 1858, started a small steel works in Sheffield, with a partner, Robert Longsdon, Messrs. Galloway, of Manchester, supplying the plant, and steel was made and sold in small quantities.

Next Robert Mushet appeared on the scene, and it appears to us to be beyond all doubt that to him the ultimate success on a great scale of the Bessemer process was due. To settle the carbon question he blew all the carbon out of the charge, and then added a definite quantity of spelgeleisen, the manganese of which formed an invaluable ingredient.

To say that Sir Henry Bessemer was a genius gives but an inadequate idea of the man. The curious way in which he got at results, almost, as it were, by instinct, was very remarkable. It is nearly certain that he never really mastered the chemistry of his process, and we are strongly disposed to believe that he took far more interest in the machinery he used than he did in the details of the process it carried out. It was quite useless to tell Bessemer that any given device would not answer. He seemed to possess some special power of making things succeed which ought to have failed. Of course he committed a multitude of mistakes, but they were all swallowed up in his successes.

A NEW SPEED INDICATOR.

The speed indicator illustrated herewith is claimed by its makers to be an improvement over the many forms of revolution counters now on the market. The unusual but convenient pistol form gives the instrument a dangerous look, but one of its chief advantages over other forms is that it will not "go off" until the trigger is pressed. This is a very desirable feature, as the point can be pressed against the shaft or revolving part continuously, and the counting can be started or stopped with great accuracy.

The ordinary speed indicators in the market begin to count as soon as the point touches the shaft, and an error is apt to occur due to the slight slip of the contact point at the start, and to the difficulty of accurately noting the instant of contact.

The dial records up to 5,000 revolutions, and then begins to repeat. If for any reason continuous counting is not desired, the register can be readily turned back to zero. The spindle revolves very freely, as it has a ball thrust bearing, and therefore requires only a slight pressure to prevent slipping at the point, the usual cause of error. Another feature which will appeal to those using a speed indicator frequently is that the dial operated by worm gears in such a manner that no matter in which direction the spindle turns the dial always counts in one direction, thus obviating any subtraction or reading backward, a frequent source of error in instruments of this sort. The instrument is put up in a leather neat plush-lined case with extra contact points and adjustment tools, and the whole weighs only 14 oz. Messrs. Lintner & Sporborg of Gloversville, N. Y., are the manufacturers of the indicator.

A NEW SPEED INDICATOR.
Lintner & Sporborg, Gloversville, N. Y. Manufacturers.

RANDOM NOTES IN SAVANNAH.

There are few cities of the South which contain more of real interest to the stranger than Savannah. It is as typically a Southern city as is Charleston, and has as much of historic interest, while its advantages as a shipping port have caused it to share in the prosperous business of the New South quite as much as Atlanta or Chattanooga. At present it ranks as the greatest naval stores market in the world, and it ships more cotton than any Atlantic port except New York. Its pre-eminence in the former field may not long be continued, however. The naval stores business has for years been moving southward as the pitch pine forests become exhausted, and the pine forests of Florida are already replacing those of Georgia as a source of the turpentine and rosin supply. At present, however, one sees at the terminals of the Savannah, Florida & Western Ry. on the Savannah River acres literally covered with barrels of rosin, and new stores are accumulated as fast as the ships take them away.

The export trade of Savannah has had a remarkable growth in the past dozen years, coincident with the improvement of the Savannah River. Where there was formerly a low tide depth of 16 ft. on the bar at its mouth, the depth is now 19 ft. The ordinary tidal rise is 6 ft. and for the most part the depth at the bar is maintained all the way up the river to Savannah, 20 miles above. At some crossings the depth is about 17 ft.; but vessels drawing 24 ft. have gone to sea from Savannah of late.

The layout of the streets in Savannah, especially in the older part of the city, is remarkable for the shortness of the blocks. In many cases the streets are no more than 60 or 70 ft. apart, and the entire area of a block is occupied by a dwelling with its tiny piece of yard in the rear enclosed by a high brick wall. The absence of lawns or yards around the houses of rich and poor alike; and not only in the city, but in the suburbs, where land is of trifling cost, is one of the most striking features of the city to a Northerner. It seems surprising that in a city whose long semi-tropic summer is its chief climatic feature every man should not seek to have at least a small plot of grass about his dwelling; but the difficulty of maintaining lawns in Savannah's sandy soil and the influence of oldtime customs, when property not enclosed by brick walls was not safe from theft, are probably the reasons why houses in Savannah are as closely crowded together as they would be in a Northern city of twice its size. The absence of lawns about the residences, however, is largely compensated for by the profusion of small parks or public squares in the older part of the city. The writer knows of no city anywhere in the country where such an extent of small parks has been provided.

The question of street paving in Savannah is a serious one for two reasons; first, the short blocks and numerous streets make the area of street surface very great in proportion to the lot area; second, the sandy soil makes paving a very desirable improvement, though, perhaps, not as necessary as in cities where mud prevails. During the past fifteen years a great amount of paving work has been done, and the principal streets in the warehouse district of the city where heavy trucking is done are fairly well paved with granite blocks. In the residence and retail shopping district enough of the principal streets have been paved with asphalt greatly to facilitate travel. A little brick pavement has been laid on a sand foundation, and under the light traffic to which it is subjected remains in very good shape. In some of the newer parts of the city some macadam streets are to be found, and some of the principal highways leading out of the city have been macadamized with chert, a material which is being used with great success in some other cities. Some of the readers of Engineering News may remember a description of the chert roads

about Birmingham, Ala., in the issue of Nov. 9, 1893. The writer has certainly never seen finer macadam roads than some of these made of chert about Savannah. They are almost as hard and smooth as asphalt, and are remarkably free from dust.

The asphalt streets in Savannah are at present in an admirable condition; but whether they will be so a year hence is a doubtful matter, for the city is now engaged in very extensive reconstruction of its sewerage system, and the street railway company is also engaged in reconstructing its lines, both of which operations are not likely to improve the street surface.

The sewerage work is being done under direction of and from plans prepared by the firm of Waring, Chapman & Farquhar. The present sewer outlet is into the Savannah River below the city. The new system will also discharge into the Savannah River by two main outlets, one above and one below the city. Some objection has been raised to this disposition of the sewage on account of possible injury to the oyster beds in the lower reaches of the river, but it is claimed that the volume of sewage is so small compared with the flow of the river that no harm can result. Should it ever become necessary to divert the sewage from the river, the sandy plain on which Savannah is located offers an ideal site for land disposal.

Savannah appears to have managed its city transit facilities with about as much or little intelligence and foresight as the average American city. Two rival companies have built up the system and have built lines enough to accommodate fairly well the city's needs, most of them, however, of pretty cheap construction. Enough competing parallel lines were built so that a war in fares ensued. Three-cent fares prevailed for nearly a year, and for some months fares were put at the unprecedented figure of one cent. The natural result was a receiver for one of the companies and the acquirement of its lines by the other.

The consolidated company of course restored fares to 5 cts. It is now laying new tracks on some of its lines, a much needed improvement, and rearranging routes and tracks, and in the end will very likely give the city a well planned system of transit, though at much greater outlay than if the work had been done by a single company at the outset.

The finest piece of architecture in Savannah is the new Government building now nearing completion; and it may be added that so far as the writer is aware no more creditable building has been designed by the Supervising Architect's Office in very many years. The building is of white Georgia marble, and is in the graceful Moorish style.

There are some interesting specimens of architecture among the old-time residences built before the war, and the same is true of some of the older churches and public buildings. The newer portions of the city, however, show a sad lack of good architecture, even in the case of buildings of expensive construction. Combinations of red brick and white marble are to be seen that are even worse than old-time Philadelphia houses, which had at least the merit of simplicity. A word of praise must be said, however, for the new county court house, a structure which would do credit to any city.

The water supply of Savannah is in quality a model of all a city water supply should be. The source of supply is a system of artesian wells to the north of the city, which was described in Engineeering News of June 8, 1893. Before the artesian supply was introduced the city used the muddy water of the Savannah River. No greater contrast in water supplies could be imagined

TABLE SHOWING PRINCIPAL FEATURES OF SPECIFICATIONS FOR PORTLAND CEMENT, AS REQUIRED BY OFFICERS OF U. S. ENGINEER CORPS, 1896-'97, WITH A FEW OTHERS INTRODUCED FOR COMPARISON.

File No.	Fineness.—Meshes. Per cent.	Fineness.—Meshes. Lin. in.	Fineness.—Meshes. Sq. in.	Test temp.	To set. Initial.	To set. Stiff.	To set. Hard.	To set. ¾-lb. w't., 1-12-in. wire.	To set. 1-lb. w't., 1-24-in. wire.	Tensile strength. Neat. Air, days. 1	7	Air and water, hours. A. W.	Air 24 hours, and water: days. 1	6	7	27	28	29	1 cement : 3 sand. Air 24 hours, and water: days. 6	7	27	28	29	Location of work and officer in charge.
1*	95	50	2,500	..	.....	.....	.....	.....	.....	...	...	.. ..	120	...	325	...	...	450	...	...	...	...	...	...	Major Quinn, Fort St. Philip, Jan. 27, 1896.
	80	100	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...	...	
3*	98	..	2,500	..	.....	.....	..... 30′	.....		...	...	.. ..	...	...	400	...	500	...	...	125	...	200	...		Major Hoxie, Herr's Island Dam, Feb. 11, 1896.
	87	..	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...	...	
								If in air or water not stated.																	
7*	95	..	4,000	60°	.....	.....	.....	.....	.....	150	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		Lieut.-Colonel Mansfield, Fort Warren, March 16, 1896.
8	96	50	.....	..	.....	.....	.....	.....	.....	70	...	.. ..	...	380	...	...	490	...	...	...	...	...	...		Major Mahan, Santa Rosa, March 26, 1896.
12	To be tested.			..	60′ to set.					250	450	.. ..	...	400	...	...	...	600	125	...	...	200	...		Major Raymond, Finn's Point, July 23, 1896.
13	95	..	2,500	..	Slow					150	...	.. ..	...	380	Such others as the Engineer di.ects.										Lieut.-Colonel Damrell, Portland, Me., July 24, 1896.
14*	95	100	10,000	60°	.....	.....	..... 30′ +	.....		..	...	12 12	...	500	...	650	...	...	...	...	...	...	...		Major Rossell, Fort Morgan, Ala., Aug. 10, 1896.
												200													
16	95	50	.....	..	.....	.....	.....	.....	.....	75	...	.. ..	...	300	...	...	400	...	...	...	...	...	...		Colonel Hains, North Point, Md., Sept. 25, 1896.
17*	100	50	.....	..	.....	.....	.....	.....	60′ +	..	...	.. ..	...	...	...	...	...	...	125	...	200	...	...		Captain Carter, Tybee, Ga., Oct. 16, 1896.
	90	100	.....	..	.....	.....	.....	.....	.....			200													
18	..	..	.....	..	60′ + to set.					250	450	.. ..	...	...	...	...	...	...	125	...	...	200	...		Colonel Gillespie, Fort Hancock, Oct. 20, 1896.
19	99	50	.....	..	.....	.....	3 h. +	.....	.....	..	...	.. ..	...	500	...	600	...	...	1 cement : 2 sand.						Lieut.-Colonel Heap, Cape Fear River, Oct. 20, 1896.
	90	100	.....	..	.....	.....	8 h. —	.....	.....										175	...	250	...	...		
	70	200	.....	..	.....	.....	.....	.....	.....																
20	95	..	2,500	..	45′ + Dark color preferred, — 3% carbonate of lime.					3% carbonate of lime.		a125	...	375	...	...	...	...	...	...	...	...	...		Major Allen, Sheridan Point, Va., Oct. 23, 1896.
21*	96	50	.....	..	.....	.....	1 h. +	.....	.....	..	...	a125	...	...	...	...	...	...	1 cement : 2 sand.						Lieut.-Colonel Benyaurd, Key West, Oct. 24, 1896.
	90	100	.....	..	.....	.....	8 h. —	.....	.....	..	...	.. ..	...	400	...	500	...	...	150	...	200	...	...		
	70	200	.....	..	.....	.....	.....	.....	.....																
22	95	50	.....	..	.....	.....	.....	.....	.....	b75	...	.. ..	...	300	...	...	400	...	...	...	...	...	...		Colonel Hains, Hawkin's Point, Md., Oct. 28, 1896.
23	95	50	.....	..	.....	.....	.....	.....	+ 60′ to set.	250	450	.. ..	...	400	...	...	...	600	125	...	...	200	...		Major Lockwood Dutch Island, R. I., Oct. 28, 1896.
	77	100	.....	..	.....	.....	.....	.....	.....	..	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
24	95	50	.....	..	.....	.....	.....	.....	.....	b75	...	.. ..	...	...	...	...	400	...	...	...	...	...	...		Major Leach, Great Gull Island, N. Y., Oct. 28, 1896.
25	85	100	.....	..	.....	.....	.....	.....	+ 60′ final set.	200	...	.. ..	...	375	...	500	...	...	125	...	175	...	...		Captain Abbot, Sullivan's Island, S. C., Oct. 9, 1896.
26	95	50	.....	..	.....	.....	.....	.....	+ 30′ to set.	200	...	.. ..	...	450	...	...	700	...	...	...	...	...	...		Major Davis, San Diego, Cal., Nov. 9, 1896.
27	95	50	.....	..	.....	.....	.....	.....	+ 30′ to set.	200	...	.. ..	...	450	...	...	700	...	...	...	...	...	...		
28	95	50	.....	..	.....	.....	.....	.....	.....	b75	...	.. ..	...	300	...	...	400	...	...	...	...	...	...		Major Miller, Galveston, Tex., Nov. 12, 1896.
29	95	50	.....	..	.....	.....	.....	Slow		175	...	.. ..	...	400	...	...	...	...	...	...	...	...	...		Lieut.-Col. Damrell, Ft. Constitution, N.H., Nov. 17, 1896.
								Such other tests as may be necessary.																	
30	95	..	2,500	..	.....	.....	.....	.....	.....	150	...	.. ..	...	380	...	...	...	...	...	...	...	...	...		Lieut.-Colonel Damrell, Portland, Me., Nov. 19, 1896.
								Such other tests as may be necessary.																	
31	96	50	.....	..	.....	.....	1 h. +	.....	.....	..	...	a125	...	400	...	500	...	...	1 cement : 2 sand.						Lieutenant-Colonel Benyaurd, Key West, Dec. 2, 1896.
	90	100	.....	..	.....	.....	8 h. —	.....	.....	..	...	.. ..	...	...	...	...	...	...	150	...	200	...	...		
	70	200	.....	..	.....	.....	.....	.....	.....																
32	95	..	2,500	..	Slow					175	...	.. ..	...	400	...	...	...	...	...	...	...	...	...		Lieutenant-Colonel Damrell, Portland, Me., Jan. 21, 1897.
								Such other tests as may be necessary.																	
33	..	..	.....	..	.....	.....	.....	.....	.....	250	450	.. ..	...	400	...	600	...	...	125	...	200	...	...		Major Raymond, Finn's Point, Jan. 22, 1897.
								Tests will be made of fineness, strength, soundness and time of setting.																	
35*	95	100	10,000	..	.....	.....	..... 30′ +	.....		..	...	12 12	...	500	...	650	...	...	...	...	...	...	...		Major Rossell, Fort Morgan, Ala., Jan. 28, 1897.
												200													
36	95	..	2,500	..	Slow; set in + 30′					b125	...	.. ..	...	Slow	400	...	...	...	...	...	...	...	...		Major Allen, Aqueduct Bridge, D. C., Feb. 20, 1897.
	..	..	.....	..	Quick; set in — 15′.					b100	...	.. ..	...	Quick	300	...	...	...	...	...	...	...	...		
								Not more than 3% carbonate of lime.																	
37	"Atlas," Alpha," or other brand of equal quality.																								Major Adams, Fort Wadsworth, N. Y., Feb. 26, 1897.
38	95	..	2,500	..	(See No. 36).																				Major Allen, Aqueduct Bridge, D. C., April 10, 1897.
39*	99	50	2,500	60°	.....	.....	.....	.....	.....	..	...	.. ..	...	...	...	...	...	...	160	...	240	...	...		Captain Chittenden, Osage City, Mo., May 14, 1897.
	88	100	10,000	..	.....	.....	..... 30′ + 60′ +			..	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
40	95	..	2,500	65°	.....	.....	..... 30′ + 60′ +			..	...	c150	...	400	...	...	...	550	125	...	...	200	...		Captain Taylor, Morrowstone Point, Wash., May 26, 1897.
	85	..	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
45	95	50	.....	..	.....	.....	.....	.....	.....	b75	...	.. ..	...	300	...	...	400	...	...	...	...	...	...		Colonel Hains, North Point, Md., June 22, 1897.
46*	95	..	2,500	65°	.....	.....	..... 30′ + 60′ +			..	...	c150	...	400	...	...	...	550	...	...	...	...	...		Captain Taylor, Admiralty Head, Wash., June 23, 1897.
	85	..	10,000	70°	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
47	95	50	.....	..	.....	.....	.....	.....	.....	250	450	.. ..	...	...	...	...	...	...	...	...	...	...	...		Captain Leach, Plum Island, N. Y., June 28, 1897.
49	95	50	.....	..	.....	.....	.....	.....	+ 30′ to set.	...	...	.. ..	...	...	...	...	...	...	125	...	...	200	...		Major Davis, San Diego, Cal., July 7, 1897.
50	95	..	4,000	60°	.....	.....	.....	.....	.....	b150	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		Lieut-Colonel Mansfield, L. I. Head, Mass., July 8, 1897.
51	85	100	.....	..	.....	.....	.....	.....	+ 60′ to set.	200	...	.. ..	...	375	...	500	...	...	125	...	175	...	...		Captain Abbot, Sullivan's Island, Aug. 10, 1897.
52	96	50	.....	..	.....	.....	.....	Mived with 33% water.		75	...	.. ..	...	380	...	...	490	...	...	...	...	...	...		Major Mahan, Fort Pickens, Aug. 19, 1897.
53*	90	50	.....	..	.....	.....	..... 60′ + + 4h.			..	...	.. ..	...	450	...	540	...	...	150	...	240	...	...		Major Marshall, Illinois & Mississippi Canal, Aug. 23, '97.
	87	100	.....	..	.....	.....	.....	.....	−12h																
55	..	..	.....	..	.....	.....	.....	.....	.....	250	450	.. ..	...	...	...	...	...	...	125	...	...	200	...		Lieut.-Col. Ludlow, Harlem River, N. Y., Sept. 13, 1897.
56*	96	50	.....	..	.....	45′ +	.....	.....	.....	...	...	c125	...	400	...	500	...	...	125	...	175	...	...		Major Powell, Monongahela River, locks, Sept. 20, 1897.
58	95	..	4,000	..	.....	.....	.....	.....	+ 30′ to set.	b300	...	.. ..	...	450	...	...	700	...	...	...	...	...	...		Captain Casey, Fort Monroe, Nov. 23, 1897.
59*	95	..	2,500	65°	.....	.....	..... 30′ + 60′ +			..	...	c150	...	400	...	...	...	550	125	...	...	200	...		Captain Taylor, Admiralty Head, Wash., Dec. 22, 1897.
	85	..	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
60	95	..	2,500	..	.....	.....	.....	.....	.....	...	...	.. ..	...	400	...	...	...	...	125	...	...	...	...		Enlargement of the Erie Canal, New York, 1896.
	90	..	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
61*	90	..	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	350	...	...	...	...	e150	...	...	...	...		New East River Bridge, New York, September, 1897.
62*	99	50	2,500	60°	30′ +	Specific gravity + 3.				..	...	.. ..	...	d175	450	...	550	...	...	160	...	220	...	...	Department of Public Works, Philadelphia, Pa., Engineering News, Vol. XXXV., page 307, 1896.
	90	100	10,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
	70	200	40,000	..	.....	.....	.....	.....	.....	...	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		
63	98	74	.....	60°	.....	.....	..... 30′ +	.....		..	...	.. ..	...	400	...	...	...	...	140	...	200	...	...		Topeka, Kan., Bridge, Eng. News, 1896, Vol. XXXV., p. 221: "It is not probable that any American natural Portlands (so called) will meet these requirements."
	95	100	.....	..	.....	.....	.....	.....	.....	..	...	.. ..	...	...	...	...	...	...	...	...	...	...	...		

*Test by thin pats in warm, or hot water, included. (a) In air until set, in water balance of 24 hours. (b) Kept in air and broken 24 hours after setting. Where two set of figures are shown, the upper one is for slow, and the lower for quick action. (c) Kept one day or until set; balance of time in water. (d) 24 hrs. in water after hard set. (e) 1 cement to 2 sand.

than the change from the sediment charged river water to the clear and sparkling well water; and the immense benefit to the city can hardly be overestimated. If only the men who work such vast benefits to a community were recompensed and honored in proportion to the benefits they confer on mankind, what a profession engineering would become! But human nature is so strange a thing that only a few weeks ago one of the aldermen of Savannah complained that the artesian well water was not nearly as good for extinguishing fires as the river water formerly used. The artesian water is so pure, according to this authority, that it runs off at once from surfaces on which it is thrown. The river water, on the other hand, plasters everything it touches with a coating of slime, which aids in retaining the water. The objector failed to state whether he would prefer to have the muddy river water applied in case his own residence should be on fire. It is evidently a very hard task to please everybody.

SPECIFICATION REQUIREMENTS FOR PORTLAND CEMENT USED BY THE U. S. GOVERNMENT.

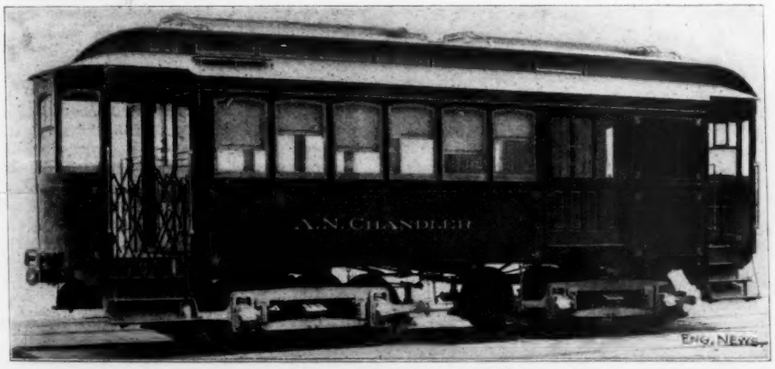
We present herewith an interesting table which has been compiled by direction of the Board of Engineer Officers in charge of fortifications, by Major C. A. P. Hatfield. Col. Henry M. Robert is President of the Board.

Some of our readers may remember that in Engineering News of July 16, 1896, et. seq., quite an extended discussion was carried on relative to the proposed formulation of standard specifications to govern all work carried on under direction of the Corps of Engineers.

The table herewith comprises such features of the specifications as it was possible to arrange in tabular form. Thus the amount of water for mixing briquettes was occasionally stated, and the same is true of the sizes of sand and the gage of wire for sieves.

A NEW COMBINATION PASSENGER AND BAGGAGE ELECTRIC CAR.

The accompanying illustration shows a combination passenger and baggage electric car which has recently been put onto the market by the J. G. Brill Co., of Philadelphia, Pa. This car is equipped with the Brill "perfect truck" for high speed, and is especially adapted for suburban lines between small towns, such as operate in great numbers in the New England and Eastern states. This car has the regular steam car platform and steps, a vestibule at each end, and is divided into passenger and baggage compartments. The length over end panels is 25 ft. 4 ins., and the width 8 ft. 4 ins. The passenger compartment is 16 ft. long and seats 22 persons, while the baggage compartment is a little less than 9 ft. long, and is sheathed with tongued and grooved boards. It is provided with 4 ft. sliding doors at each side, an end door, and a door to swing into the passenger compartment. This last door is fitted with a glass sash. The platforms are 4 ft. 6 ins. wide and the roof is of the regular steam car pattern, two trolley poles and boards are provided so that the car may run in either direction. Two trolley poles are found desirable upon these long cars. There are two sand boxes, two gongs, and gates to the vestibules. There are six windows on each side of the passenger compartment which is fitted with cherry slat seats. Drop seats are also placed in the baggage compartment for use in case of crowding and for the accommodation of smokers. Altogether the car is as comfortable and convenient as could be desired for use on a road where high speeds are needed between stations separated by short intervals. Cars of this type enable a frequent train service to be maintained with a very small expense for wages. Only two men are needed to operate the car.



A COMBINATION PASSENGER AND BAGGAGE CAR FOR SUBURBAN ELECTRIC RAILWAY SERVICE. J. G. Brill Co., Philadelphia, Pa., Builders.

THE 8-TRACK RAILWAY DRAWBRIDGE which is to cross the Chicago Drainage Canal at Campbell Ave. has attracted much attention in engineering circles and considerable interest centers upon the type of bridge to be adopted. The bridge is to be built by the Trustees of the Sanitary District, but the design is subject to the approval of the three companies which will use the bridge, namely, the Pittsburg, Cincinnati, Chicago & St. Louis Ry. (Pennsylvania Lines, 4 tracks); the Chicago & Northern Pacific R. R. (2 tracks) and the Union Stock Yards & Transit Co. (2 tracks). The Board of Trustees had designs for this bridge made by its own engineers; but in calling for bids on these designs it also invited competitive designs. The plans prepared by Mr. Hughes, consulting engineer for bridges to the Chicago Sanitary Disthict, provided for a center-pivot swing bridge, 399 ft. 2⅝ ins. long and 116 ft. 6 ins. wide. This was to have four main trusses, 68 ft. deep at the center and 29 ft. 6 ins. apart, c. to c., with two tracks between each pair of trusses, while the cantilever ends of the floor beams were to carry a single track outside of each outer truss. The turntable drum was to be 78 ft. 7 ins. diameter and 6 ft. 8 ins. deep, resting on a live ring of 144 cast steel rollers. The general character of the design was similar to that of the double track railway drawbridges over the canal, illustrated in our issue of Dec. 2, 1897, but of course the members and details were to be of enormous size. Three competitive designs were submitted in answer to the invitation of the Trustees: (1) A rolling lift bascule bridge of 150 ft. span, with no center pier; this was submitted by the Scherzer Rolling Lift Bridge Co., of Chicago, and proposed a bridge of the same general type as the three Scherzer bridges now in operation on the Chicago River; it was to consist of four independent double-track spans, so connected as to be operated either simultaneously or as four separate units. (2) A bridge with three piers and two 80-ft. plate girder spans; these spans to be lifted vertically off their seats and run back by two large travelers spanning the railway tracks and running on rails parallel with these tracks; this was submitted by Mr. C. L. Strobel, M. Am. Soc. C. E., of Chicago, and though this system has never yet been tried it was claimed that it would be economical in construction and operation, especially as only one traveler need be built at first. (3) A double-leaf drawbridge, with each leaf running to and fro on rails parallel with the railway tracks, and having its outer end supported by a trestle tower whose base would rest on wheels running on a track across the bottom of the canal; this design was proposed by Mr. Onward Bates, M. Am. Soc. C. E., and was submitted by the Edge Moor Bridge Works, of Wilmington, Del.

Having considered the designs, and the bids which have already been given in our columns, the Board of Trustees adopted the swing bridge design of Mr. Hughes, and awarded contracts for the substructure and superstructure. It was taken for granted by the Board that the approval of the railway companies had been obtained. This was found not to be the case, however, and the railways protested against the adopted design, objecting specially to having all the tracks on one large structure, any obstruction or accident to which would block every line. After much delay and negotiation in unsuccessful attempts to induce the railway companies (led by the Pennsylvania Lines) to change their position, the Board definitely abandoned the swing-bridge design and made overtures to purchase either Mr. Scherzer's or Mr. Strobel's designs, but was unable to come to terms with the latter, while the former declined to sell his plans. It will be seen at once that the difference of conditions as to span and waterway prevents any direct comparison between the costs of the bridges under these designs. The latest development was an arrangement arrived at last week, under which the Board has secured options on both these designs for certain sums, with provision for further payments in case of the acceptance of either one. At the same time the competition is again thrown open for the admission of other competitive plans. At the present time, therefore, the only point definitely decided upon is the rejection of the designs for a single swing bridge carrying eight tracks, and the final outcome of the negotiations will be looked for with much interest.

STATE AID FOR ROAD CONSTRUCTION in New York state was authorized by the legislature, recently adjourned, and the act has been approved by the governor. Under this legislation the state pays 50%, the county 35% and property-owners 15% of the cost of road improvements, the total amount of available state money being determined by the legislature each year. The initiative for any given piece of work lies with the abutting property-owners. If a majority of these petition for the improvement of a road the County Supervisors must call upon the State Engineer for surveys and estimates. After these are received the supervisors order or refuse to order the improvement, as they see fit. Similar aid in other states, differing somewhat in detail of execution, has worked remarkably well, and there seems to be no reason why it should not do the same in the Empire State.

A CABLEWAY FOR EXTRACTING ICE from a glacier is being operated at Briancon, France, by the Societe des Glacieres, of Paris, for the ice supply of Marseilles and Lyons. The ice-blocks are carried on the cableway a distance of 1,25 miles to the railway. The system used is that known as the "three cable continuous movement" type. The fixed steel carrier cable for the full down load is 18 mm. diameter, and that for taking back the empty carrier is 15 mm. diameter. These two cables are supported upon 14 piers of wood and they are located 2 meters apart, horizontally. The endless traction cable, attached to the two-wheel trolley on the carrier cable at some distance below its center, is 10 mm. diameter. The difference in elevation of the ends of the cableway is 1,312 ft., and as a consequence the trolley works automatically; not only taking down the ice by its own weight, but also hauling up the empty carriers. A hand brake takes care of the surplus power. Both ice-tongs and cages are used, and ice-blocks, weighing 330 lbs. each, are sent down at the rate of one per minute. This means the delivery of about 100 tons of ice in 12 hours. The cost of the plant ready for operation was about $5,000.

THE PHILADELPHIA EXPOSITION OF 1899, according to a preliminary prospectus just issued, will be held from May to October, 1899, and outlines the plan as follows:

1. To show foreign buyers the goods American manufacturers offer to export, and to establish their superiority.
2. To show American manufacturers the character of goods they must compete with in the open markets of the world.
3. To show how American goods should be packed, labeled and put up for export trade.
4. To bring the manufacturers and merchants of the United States in direct personal contact with the principal buyers, merchants and bankers of foreign countries.

There will be three divisions of the Exposition, the most important being the exhibit of American manufactures. In the second division will be shown samples of successful foreign export articles, while the third department will illustrate methods of packing. Mr. Wm. Harper is the Director General.

A "TELECTROSCOPE," or apparatus for transmitting monochromatic pictures by electricity is reported from Vienna to have been invented by Jan Szczepanik, a Polish schoolmaster. The description, as given in a letter in the New York "Times" of April 3, indicates that the theory of the apparatus is a reasonable one. The picture is resolved into a succession of dots at the transmitting station by means of two line mirrors, or mirrors coated with an opaque substance, except a single bright reflecting line, placed at right angles. These reflect the light from each point of the picture in succession upon a selenium cell, which varies an electric current according to the strength of the light it receives. At the receiving station this varying current is used to vary the intensity of a single pencil of light which is reflected by two line mirrors which oscillate synchronously with those at the sending station and

throw on a screen a succession of dots of light which correspond in intensity and position with the points of the picture which are being reflected onto the selenium cell at the sending station. It is stated that the whole operation occupies less than the tenth of a second, so that the rapid succession of the dots of light on the screen has the appearance to the eye of an actual picture.

ALUMINUM FOR ARMY EQUIPMENTS has been officially adopted by France. In the late army budget is an appropriation of $25,000 to be expended in beginning the manufacture and distribution of the new equipments. These will include the individual plate or bowl, canteen, quart cup and the boiling-pot and bowl for messes of four men. In 1894 500 sets were put upon trial, and during the Madagascar campaign 15,000 sets were used with great satisfaction. In the latter set was a "kidney plate," so called from its shape; it rested better on the knapsack and did not interfere with head movement, as did the circular plate. The use of the aluminum will reduce the weight of these equipments by one half, and sea-air and salt-water will not affect them. The difficulty in soldering is overcome by ferruling the seams. The French price of aluminum is given at 26 cts. per pound by U. S. Commercial agent W. P. Atwell, of Roubaix, who publishes this statement in the "Consular Reports" for March, 1898.

LATERAL AND VERTICAL STRESSES IN GRAIN TANKS.

By Max Toltz, Assoc. M. Am. Soc. C. E.

A bin filled with grain of the weight per unit volume γ (gamma) and the angle of natural slope ρ is assumed to have below the depth x (Fig. 1) a uniform area F with a constant circumference U. Also let P_1 represent the vertical, P_2 the corresponding lateral (i. e. in a horizontal direction) normal pressure upon the unit of surface, both being variable with x, and being taken without great error as uniform for all points on a horizontal section; to be more correct, the points for the vertical pressure P_1 would be located on the surface of a cupola (dome) due to a resultant reaction of an angle ρ, with a horizontal line (Fig. 2).

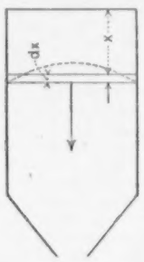


Fig. 1.

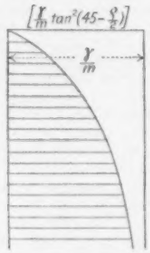


Fig. 4.

The weight of the grain between the sections at x and x + d x (Fig. 3) = F. dx. γ; the total frictional force acting upwards at the circumference $= P_2 \tan \rho_1 U\, dx.$; the total perpendicular pressure upon the upper surface $= P_1 F$; and the total pressure upon the lower surface $= (P_1 + d P_1) F$. These vertical forces are in equilibrium, therefore, their sum =O, which gives the equation,

$$P_1 F - (P_1 + d P_1) F + F.\, dx.\, \gamma - P_2 \tan \rho_1.\, U.\, dx. = 0$$

$$d P_1 = dx. \left(\gamma - P_2 \tan \rho_1 \frac{U}{F}\right). \qquad (1)$$

According to well-known laws,

$$P_2 = P_1 \tan^2\left(45 - \frac{\rho}{2}\right); \qquad (2)$$

and substituting P_2 in formula (1) we get,

$$d P_1 = dx \left[\gamma - P_1 \tan^2\left(45 - \frac{\rho}{2}\right). \tan \rho_1 \frac{U}{F}\right]$$

Let, for abbreviation, the constant factor

$$\tan^2\left(45 - \frac{\rho}{2}\right). \tan \rho_1 \frac{U}{F} = m, \quad \text{then}$$

$$d P_1 = dx.\, (\gamma - m P_1), \text{ or}$$

$$\frac{d P_1}{\gamma - m P_1} = dx; \text{ from which by integration,}$$

$\log. (\gamma - m P_1) = - mx + C$; if x = O, then $P_1 = O$; $C = \log. \gamma$. We now get,

$$\log. \frac{\gamma - m P_1}{\gamma} = - mx, \text{ or}$$

$$\frac{\gamma - m P_1}{\gamma} = \frac{1}{e^{mx}}; \quad e =$$

therefore,

$$P_1 = \frac{\gamma}{m}\left(1 - \frac{1}{e^{mx.}}\right); \qquad (3)$$

and according to equation (2)

$$P_2 = \frac{\gamma}{m}\left(1 - \frac{1}{e^{mx.}}\right) \tan^2\left(45 - \frac{\rho}{2}\right). \qquad (4)$$

According to these values of P_1 and P_2 the vertical pressure (including pressure on bin bottom), as well as the lateral pressure upon the walls, increase with the depth, for the fraction $\frac{1}{e^{mx}}$ decreases with the increase of x.

If x = O, then $P_1 = O$ and $P_2 = O$.

Substituting now the proper value for m, gives

$$P_1 = \frac{\gamma F}{U} \cdot \frac{1}{\tan \rho_1 \tan^2\left(45 - \frac{\rho}{2}\right)} \cdot \left(1 - \frac{1}{e^{\tan \rho_1 \tan^2\left(45 - \frac{\rho}{2}\right)\frac{U x}{F}}}\right);$$

$$P_2 = \frac{\gamma F}{U} \cdot \frac{1}{\tan \rho_1} \cdot \left(1 - \frac{1}{e^{\tan \rho_1 \tan^2\left(45 - \frac{\rho}{2}\right)\frac{U x}{F}}}\right).$$

We can easily see that both the vertical as well as the lateral pressure increase with tha ratio $\frac{F}{U}$, or in other words, the greater the area in proportion to the circumference, the greater the stresses will be. They will be largest in a cylindrical bin, and larger in a hexagon bin than in a square one.

P_1 as well as P_2 = zero if x = 0, and they reach the highest value when $\frac{1}{e^{mx}} = O$ or $x = \infty$; and in this case the possible max. values are,

$$P_1 \max = \frac{\gamma}{m} \text{ and } P_2 \max. = \frac{\gamma}{m} \tan^2\left(45 - \frac{\rho}{2}\right).$$

Koenen's results agree with the ones arrived at from experiments made by Delanger, Hagen, Engesser, Forchheimer and others, and show that with the increasing height of the filled material the pressure on the bottom of a bin approaches a limit.

If the value P_1 and P_2 are represented by horizontal ordinates of a curve (Fig. 4), then this curve has an asymptote perpendicular to the ordinate at a distance $\frac{\gamma}{m}$ and $\left[\frac{\gamma}{m} \tan^2\left(45 - \frac{\rho}{2}\right)\right]$ respectively from the line of abscissas.

This general formula,

$$P_1 = \frac{\gamma\left(1 - e^{(-)\tan^2\left(45 - \frac{\rho}{2}\right)\tan \rho_1 \frac{U}{F} x}\right)}{\tan^2\left(45 - \frac{\rho}{2}\right)\tan \rho_1 \frac{U}{F}}$$

should be applied in the case of water, where $\rho = O$, therefore, $\tan^2\left(45 - \frac{\rho}{2}\right) = 1$; $\rho_1 = O$, also; consequently $P_1 = \frac{\gamma}{O}$.

The first derivative of the numerator with respect to ρ_1, divided by the first derivative of the denominator with respect to ρ_1 gives,

$$\frac{\gamma x \frac{U}{F} e^{-\tan \rho_1 \frac{U}{F} x}}{\frac{\frac{U}{F}}{\cos^2 \rho_1}} \cdot \frac{\cos^2 \rho_1}{1}$$

Substituting now ρ_1 with O, the well-known formula for water is gotten, viz.:

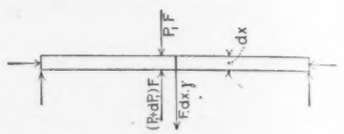
$$P_1 = \gamma x;\ P_2 = \gamma x,$$

which proves that this formula can be applied in a general way.

The above formula will only hold good if the contents in the bins are at rest. Recent experiments made by Mr. Prante, C. E., Hamburg, Germany, show that the lateral pressures increase when the contents in the bin are in motion. The method and apparatus used for these experiments are fully described in Zeitschrift Des Vereins Deutcher Inginieure, Vol. 4X, No. 36, 1896. It may be said here that the first apparatus was insufficient, and a more perfect one was, therefore, constructed.

Mr. Prante's experiments were about as follows: The measurements were taken of a cylinder of 12.41 ft. diameter as well as one of 4.92 ft. diameter. The grain was put into the bin to which the apparatus was attached and was leveled off at any desired height. The perpendicular distance of the top surface of grain above the center of the piston is called the pressure height. From the scale pan well laden with small weights, units are removed until the scale balances. By referring to the length of lever arms, the weights removed are to the horizontal pressure of grain as 1 to 2½. To

Fig. 2.



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It is hoped that in further experiments surer observations and measurements will be permissible with sufficient accuracy to determine the law of increase of lateral pressure with increase of velocity of movement of grain, and thereby, perhaps, to introduce the application to the determination of the earth pressure on retaining walls.

ENGINEERING NEWS
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THE EAST CHANNEL OF NEW YORK HARBOR has been reported upon by Lt.-Col. William Ludlow, Engineer Corps, U. S. A., in regard to its improvement as an entrance to New York. Col. Ludlow favors the improvement of the East Channel, and thus differs from Col. Gillespie, who recommended the deepening of the Main Channel. He estimated that a channel 2,000 ft. wide and 35 ft. deep could be made for $3,200,750, including $800,000 for four powerful pump dredges. If this work should be let by contract, however, he would add 20% for profit to the above amount. A channel 1,000 ft. wide and 35 ft. deep could be made in 15 months, while the full width of 2,000 ft. would require from 2½ to 3 years for completion. In the detail report submitted Col. Ludlow says that the East Channel is a well-marked result of the ebb-flow and carries to sea the greater portion of the outflow from the Hudson River Basin. He considers it as the old bed of the river, and it maintains a broad channel over 30 ft. deep for 4½ miles below the 35 ft. contour of the deep water south of the Narrows; passing completely through the main crest of the bar. The present Main Ship Channel makes sharp angles and requires dredging, to a greater or less extent for deepening and maintenance. The East Channel is almost direct, and it would be comparatively easy to open it, as it is the natural main outlet for the ebb tide through the Narrows, and has the deepest and widest natural channel across the bar. Owing to its powerful discharge and to the directness and uniformity with which the tidal currents traverse it, both in ebb and flow, it has always maintained its natural superiority without artificial aid; and has, in fact, pushed its deep contours seaward. For commercial purposes it is also the shortest channel; the distance between the 35-ft. contours, inside and out, is 6¼ miles, or 5 miles less than by the present ship channel. For the 2,000-ft. wide, 35-ft. deep channel, the quantity to be dredged is estimated at 29,100,000 cu. yds., including allowance for slopes of 10 to 1, for wash and scour and 25% added for difference between scow and place measurement. The material is sand, gravel and mud, and this should be removed for from 3¾ to 7 cts. per cu. yd. The dredging steamer deepened the Gedney Channel at a cost of about 5 cts. per cu. yd.; and Col. Ludlow uses 7 cts. for work on the bar, with 10% added for contingencies.

CONCERNING THE PORT ARTHUR SHIP CANAL project, referred to in our issue of March 31, we note the following from official sources: Major James B. Quinn, Engineer Corps, U. S. A., in his official report to the War Department, says that at the entrance to the proposed canal he found a cut 200 ft. long, 50 ft. wide and 12 ft., and no part of the canal more than 16 ft. deep, as yet. He also found the location of the canal dangerously near the lake and liable to erosion, and reported danger from silting from the lake and from Taylor's Bayou. Major Quinn recommended that the proposed bulkhead be built without openings after Mud Bayou is reached, and that a complete barrier be maintained at this point until a satisfactory scheme for a disposal of drainage is proposed by the company and approved by the Secretary of War. On March 24, the Chief Engineer of the Port Arthur Channel & Dock Co. filed with the Secretary of War a report, plans and specifications dealing with this subject, and had a personal interview with the Secretary. As a result, Gen. John M. Wilson, Chief of Engineers, acting under instructions from Secretary of War Alger, has now directed Major Quinn "not to interfere with the canal work of the Port Arthur Co., as projected, unless he feels sure that it will result disadvantageously to the government work at Sabine Pass." If such a question arises he is to report the facts with recommendations, by telegraph, to the Secretary of War. The objection to the plans are thus removed, for the time at least; and since the above order was issued the entire connection between Taylor's Bayou and the canal has been dredged. At the present time about 3½ miles of the canal are completed to a depth of 16 ft., and three hydraulic dredges are at work.

THE SUGAR BEET INDUSTRY OF EUROPE is reported upon as follows by U. S. Consul-General Julius Goldschmidt, of Berlin: Germany, in 1896-97, operated 399 factories, consumed 13,721,000 tons of beets and produced 1,738,885 tons of sugar in the year. This is at the rate of 790 lbs. of beets to produce 100 lbs. of sugar. France, in the same year, consumed about half the amount of beets, and made 703,300 tons of sugar; and Austria-Hungary made 929,000 tons of sugar. Russia also produced 734,400 tons; and Belgium, Holland and Sweden added 280,000, 156,000 and 106,400 tons to this product, respectively. The wholesale price of raw sugar at Magdeburg, at 88%, has fallen from $6.80 per 100 lbs., in 1859-60, to $2.14 in 1896-7. The growth of this industry, in thirty years, is largely due to protection and bounties, which have stimulated scientific research, mechanical ingenuity and intelligent husbandry. Germany is now the largest sugar exporting country in the world. In 1896-97 she shipped abroad nearly 850,000 tons of beet sugar, over one-half of which came to the United States. Her own population of 52,500,000, in 1895-96, used over 30 lbs. per head (the consumption of the United States is about 54 lbs. per head). Deducting $4,334,000 paid in 1895-96 for export bounties, the total amount received by the country for its sugar exported in that year was nearly $25,000,000. The production of beets per acre has also increased from 11½ to 13½ tons, without exhausting the soil. The price paid for beets is now about $4 per ton.

THE DEVELOPMENT OF THE SUGAR-BEET INdustry in the United States is being seriously promoted by the U. S. Department of Agriculture, and within the last year seeds were sent to over 10,000 farmers in different parts of the country, and 2,300 of the samples produced from this seed have been analysed by government experts. The best results came from the states of New York and Michigan, though the results in eight other states were generally favorable. The New York beets weighed about 30 oz. each, and contained about 19% of sugar on the average. The average yield of 41,272 acres for the year was almost 9½ tons of beets per acre; and the returns of the Department for 1897 show a production for the United States of 90,491,670 lbs. of beet sugar in that year. This is equivalent to 232 lbs. of sugar per ton of 2,000 lbs., or 11.6% of the weight of the beets. Secretary Wilson states that at least 80,000 acres will be planted with beets in 1898, and the expected yield is 800,000 tons of beets, or 180,000,000 lbs. of sugar, or nearly 4% of the total import of sugar, now amounting to about 2,000,000 tons per annum. During the calendar year of 1897 more than 1,373,000,000 lbs. of beet sugar were imported into the United States, and there is evidently room for the development of this industry, with profit to the country. The attempt to mix up this growing industry with the Hawaiian question, and against annexation as liable to ruin the industry, is met by the assertion that the sugar beet business of the United States would have to expand to 1,500,000 tons per annum before it would begin to compete with Hawaiian sugar. Mr. James T. Taylor, M. Am. Soc. C. E., and Chief Engineer of the Pecos Irrigation & Improvement Co., of New Mexico, writes that to produce in this country the 84% of sugar now annually imported from foreign countries, other than Hawaii, would utilize the beet production of 1,650,000 acres, at an average of 10 tons of beets per acre. At $4 per ton, the average price now paid for beets, this would represent $66,000,000 annually expended among our own producers.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on April 6, on the Naugatuck Division of the New York, New Haven & Hartford R. R., about two miles above Thomaston, Conn. About 30 workmen were in the caboose attached to the rear of a wrecking train. One of the cars jumped the track while crossing the West Branch bridge, and was followed by the caboose, which crashed through the side of the bridge, killing three men and seriously injuring two.

THE EXPLOSION OF A CAR LOAD OF DYNAMITE on April 7 killed three trainmen, wrecked a bridge and completely destroyed 10 freight cars. The accident occurred on the Montana Central Ry., at a place called Dry Forks, about 60 miles from Great Falls, Mont., and is supposed to have resulted from the jar caused by the dynamite car running off the track.

AN AVALANCHE ON THE DYEA TRAIL, Alaska, occurred about April 3, and, according to press reports, between 50 and 100 persons were killed. There were several small slides, and many persons were endeavoring to leave the vicinity when the large slide occurred, covering the trail for several hundred yards to a depth of 50 ft. It is estimated that 10,000 tons of outfits are buried under the snow and ice.

THE BURSTING OF ONE OF THE LARGE GUNS at Morro Castle, Havana, is reported to have occurred on April 7 while target practice was in progress. It is stated that seven men were killed.

THE NEW YORK GRADE CROSSING ACT OF 1897 will be carried into effect by an appropriation of $100,000 for the coming year, granted to the Railway Commission. Under the law the commission is authorized to expend $10,000 of this amount for a superintendent of bureau and other clerical assistance. This appropriation practically makes $400,000 available this year, as the state only pays one-fourth of the cost of all changes. At present there are no applications for grade crossing work before the commission; but owing to the uncertainty of the passage of the appropriations, little has yet been done by the commission in organizing the new bureau.

RAILWAY MOTOR-CARS are being built by the Nord Railway, of France. Two types are to be constructed; one operated by steam, on the Serpollet system, and the other fitted with storage batteries and electric motors. The first type is intended for the postal service and will carry no passengers; and will enable the company to deliver mail at times when a regular train would be practically useless. But they are designed also to haul one or two light carriages for passengers should the demand arise. The second, or electric type, is intended exclusively for passengers; to be employed on temporary service at seaside resorts, in the season; for a permanent secondary service on the regular lines in or near large cities; and for light service on special feeding lines, or to run between trains on more important lines. These motor-cars are described at length in the "Revue Generale des Chemins de Fer" for March, 1898. In an experimental trip, with the Serpollet system, with a motor-car, one passenger and one baggage car, weighing in all 36.25 metric tons, an average speed of about 27 miles per hour was maintained for a two-hour trip. The consumption of briquette fuel and water per mile was 91 lbs. briquette fuel, and 4.3 gallons of water. The cost of the electric operation is not stated.

A PATTON MOTOR CAR, built by the Patton Motor Co., of Chicago, for a street railway at Cedar Rapids, made its trip to the latter city under its own power. The run of 279 miles, over the Chicago Great Western Railway, was made in 16 hours, with a consumption of 58 gallons of gasoline. The car is operated by a gas engine directly connected to a dynamo, surplus current being stored by a set of battery cells, as described recently in our columns. Some of these cars are now being built for use at Chattanooga, Tenn.

JAPANESE RAILWAY PROGRESS, says the "Japan Times," has been phenomenal. The first 18 miles of railway, between Tokyo and Yokohama, was built in 1872. Since that date the system has extended at an average rate of about 100 miles per year, and the total mileage was 2,446 miles on March 30, 1897. But in the last year 530 miles was added, making 3,000 miles in round numbers. The progress is due both to government and private enterprise.

MUNICIPAL OWNERSHIP OF ELECTRIC LIGHT and power is in operation in the following cities of Germany, which own and manage the works: Bremen, Barmen, Cassel, Darmstadt, Dusseldorf, Elberfield, Hanover, Cologne, Konigsberg, Lubeck and Pforsheim. Except Hanover, all these cities also own the gas works. Aix la Chapelle, Chemnitz, Frankfort, Strasburg and Stuttgart have all built their own electric works, but lease them for operating to private corporations; and with the exception of Chemnitz the gas works are also managed by private companies. In the following cities private corporations have built electric works, with the understanding that the cities can purchase them under certain conditions: Altoona, Dessau, Gera, Hagen, Heilbronn, Leipsic, Mulhausen, Stettin and Zwichau. The gas works are owned by private companies in Dessau, Hagen, Mulhausen and Zwichau.

THE CENTRAL ELECTRIC LIGHTING STATIONS in the United States, according to the "American Electrical Directory," now number 2,594. Of this number 2,261 are owned and operated by private corporations, firms and individuals, while 333 are municipal plants. The former represent an investment of $229,938,605, and include 264,428 arc lamps, and 7,234,134 incandescent lamps, requiring 970,481 HP. of engines. The latter include 26,087 arc lamps, 371,440 incandescent lamps, and require 67,740 engine HP. for operation.

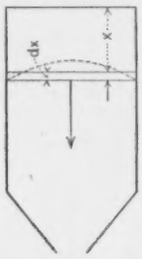
throw on a screen a succession of dots of light which correspond in intensity and position with the points of the picture which are being reflected onto the selenium cell at the sending station. It is stated that the whole operation occupies less than the tenth of a second, so that the rapid succession of the dots of light on the screen has the appearance to the eye of an actual picture.

ALUMINUM FOR ARMY EQUIPMENTS has been officially adopted by France. In the late army budget is an appropriation of $25,000 to be expended in beginning the manufacture and distribution of the new equipments. These will include the individual plate or bowl, canteen, quart cup and the boiling-pot and bowl for messes of four men. In 1894 500 sets were put upon trial, and during the Madagascar campaign 15,000 sets were used with great satisfaction. In the latter set was a "kidney plate," so called from its shape; it rested better on the knapsack and did not interfere with head movement, as did the circular plate. The use of the aluminum will reduce the weight of these equipments by one half, and sea-air and salt-water will not affect them. The difficulty in soldering is overcome by ferruling the seams. The French price of aluminum is given at 26 cts. per pound by U. S. Commercial agent W. P. Atwell, of Roubaix, who publishes this statement in the "Consular Reports" for March, 1898.

LATERAL AND VERTICAL STRESSES IN GRAIN TANKS.

By Max Toltz, Assoc. M. Am. Soc. C. E.

A bin filled with grain of the weight per unit volume γ (gamma) and the angle of natural slope ρ is assumed to have below the depth x (Fig. 1) a uniform area F with a constant circumference U. Also let P_1 represent the vertical, P_2 the corresponding lateral (i. e. in a horizontal direction) normal pressure upon the unit of surface, both being variable with x, and being taken without great error as uniform for all points on a horizontal section; to be more correct, the points for the vertical pressure P_1 would be located on the surface of a cupola (dome) due to a resultant reaction of an angle ρ, with a horizontal line (Fig. 2).



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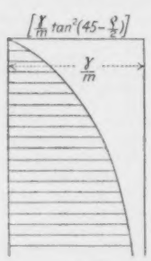

Fig. 4.

The weight of the grain between the sections at x and x + d x (Fig. 3) = F. dx. γ; the total frictional force acting upwards at the circumference = $P_2 \tan \rho_1$ U dx.; the total perpendicular pressure upon the upper surface = P_1 F; and the total pressure upon the lower surface = $(P_1 + d P_1)$ F. These vertical forces are in equilibrium, therefore, their sum =O, which gives the equation,

$$P_1 F - (P_1 + d P_1) F + F. dx. \gamma - P_2 \tan \rho_1, U. dx. = 0$$

$$d P_1 = dx. \left(\gamma - P_2 \tan \rho_1 \frac{U}{F}\right). \quad (1)$$

According to well-known laws,

$$P_2 = P_1 \tan^2\left(45 - \frac{\rho}{2}\right); \quad (2)$$

and substituting P_2 in formula (1) we get,

$$d P_1 = dx \left[\gamma - P_1 \tan^2\left(45 - \frac{\rho}{2}\right). \tan \rho_1 \frac{U}{F}\right]$$

Let, for abbreviation, the constant factor

$$\tan^2\left(45 - \frac{\rho}{2}\right). \tan \rho_1 \frac{U}{F} = m, \quad \text{then}$$

$$d P_1 = dx. (\gamma - m P_1), \text{ or}$$

$$\frac{d P_1}{\gamma - m P_1} = dx; \text{ from which by integration,}$$

$$\log. (\gamma - m P_1) = -mx + C; \text{ if } x = 0, \text{ then } P_1 = 0; \; C = \log. \gamma.$$

We now get,

$$\log. \frac{\gamma - m P_1}{\gamma} = -mx, \text{ or}$$

$$\frac{\gamma - m P_1}{\gamma} = \frac{1}{e^{mx}}; \quad e =$$

therefore,

$$P_1 = \frac{\gamma}{m}\left(1 - \frac{1}{e^{mx}}\right); \quad (3)$$

and according to equation (2)

$$P_2 = \frac{\gamma}{m}\left(1 - \frac{1}{e^{mx}}\right) \tan^2\left(45 - \frac{\rho}{2}\right). \quad (4)$$

According to these values of P_1 and P_2 the vertical pressure (including pressure on bin bottom), as well as the lateral pressure upon the walls, increase with the depth, for the fraction $\frac{1}{e^{mx}}$ decreases with the increase of x.

If x = O, then $P_1 = O$ and $P_2 = O$.

Substituting now the proper value for m, gives

$$P_1 = \frac{\gamma F}{U} \cdot \frac{1}{\tan \rho_1 \tan^2\left(45 - \frac{\rho}{2}\right)} \cdot \left(1 - \frac{1}{e^{\tan \rho_1 \tan^2\left(45 - \frac{\rho}{2}\right)\frac{U x}{F}}}\right);$$

$$P_2 = \frac{\gamma F}{U} \cdot \frac{1}{\tan \rho_1} \cdot \left(1 - \frac{1}{e^{\tan \rho_1 \tan^2\left(45 - \frac{\rho}{2}\right)\frac{U x}{F}}}\right).$$

We can easily see that both the vertical as well as the lateral pressure increase with tha ratio $\frac{F}{U}$, or in other words, the greater the area in proportion to the circumference, the greater the stresses will be. They will be largest in a cylindrical bin, and larger in a hexagon bin than in a square one.

P_1 as well as P_2 = zero if x = 0, and they reach the highest value when $\frac{1}{e^{mx}} = O$ or $x = \infty$; and in this case the possible max. values are,

$$P_1 \max = \frac{\gamma}{m} \text{ and } P_2 \max. = \frac{\gamma}{m} \tan^2\left(45 - \frac{\rho}{2}\right).$$

Koenen's results agree with the ones arrived at from experiments made by Delanger, Hagen, Engesser, Forchheimer and others, and show that with the increasing height of the filled material the pressure on the bottom of a bin approaches a limit.

If the value P_1 and P_2 are represented by horizontal ordinates of a curve (Fig. 4), then this curve has an asymptote perpendicular to the ordinate at a distance $\frac{\gamma}{m}$ and $\left[\frac{\gamma}{m} \tan^2\left(45 - \frac{\rho}{2}\right)\right]$ respectively from the line of abscissas.

This general formula,

$$P_1 = \frac{\gamma\left(1 - e^{(-)\tan^2\left(45 - \frac{\rho}{2}\right)\tan \rho_1 \frac{U}{F} x}\right)}{\tan^2\left(45 - \frac{\rho}{2}\right)\tan \rho_1 \frac{U}{F}}$$

should be applied in the case of water, where $\rho = O$, therefore, $\tan^2\left(45 - \frac{\rho}{2}\right) = 1$; $\rho_1 = O$, also; consequently $P_1 = \frac{O}{O}$.

The first derivative of the numerator with respect to ρ_1, divided by the first derivative of the denominator with respect to ρ_1 gives,

$$\frac{-\tan \rho_1 \frac{U}{F} x \; \gamma x \frac{U}{F} e}{\frac{U}{F} \cdot \frac{1}{\cos^2 \rho_1}}$$

Substituting now ρ_1 with O, the well-known formula for water is gotten, viz.:

$$P_1 = \gamma x; \; P_2 = \gamma x,$$

which proves that this formula can be applied in a general way.

The above formula will only hold good if the contents in the bins are at rest. Recent experiments made by Mr. Prante, C. E., Hamburg, Germany, show that the lateral pressures increase when the contents in the bin are in motion. The method and apparatus used for these experiments are fully described in Zeitschrift Des Vereins Deutcher Ingnieure, Vol. 4X, No. 36, 1896. It may be said here that the first apparatus was insufficient, and a more perfect one was, therefore, constructed.

Mr. Prante's experiments were about as follows: The measurements were taken of a cylinder of 12.41 ft. diameter as well as one of 4.92 ft. diameter. The grain was put into the bin to which the apparatus was attached and was leveled off at any desired height. The perpendicular distance of the top surface of grain above the center of the piston is called the pressure height. From the scale pan well laden with small weights, units are removed until the scale balances. By referring to the length of lever arms, the weights removed are to the horizontal pressure of grain as 1 to 2½. To

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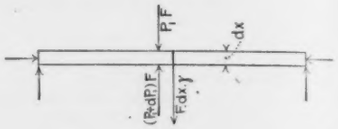

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Again, experiments were made on the small bin, during which grain was put in at the top faster than it flowed from the bottom. In this experiment the pressure height increased while the whole mass of contents moved downward with a velocity of 0.04 ins. per second.

Experiments, incomplete as they are, show clearly that the pressure of the grain against the bin wall is very small as long as the grain is at rest, but that even a slight motion is sufficient to multiply the lateral pressure.

It seems, therefore, with the increase of velocity of the discharging grain, the lateral pressure approaches more nearly that of a hydraulic or liquid pressure of the same specific gravity as the grain. From the previous experiments, the purpose of which were for the determination of the correct measurements for bin walls, the discoveries made in many places of the tearing of bin walls are accounted for as being due to insufficient strength or too weak anchorage.

It is hoped that in further experiments surer observations and measurements will be permissible with sufficient accuracy to determine the law of increase of lateral pressure with increase of velocity of movement of grain, and thereby, perhaps, to introduce the application to the determination of the earth pressure on retaining walls.